# Stock Assessment and Fishery Evaluation of Skate species (*Rajidae*) in the Gulf of Alaska

by
Sarah Gaichas[1], Michael Ruccio[2], Duane Stevenson[1], and Rob Swanson[3]

[1]NMFS Alaska Fisheries Science Center, Seattle WA
[2]ADF&G Commercial Fisheries Division, Kodiak AK
[3]NMFS Alaska Fisheries Science Center, Kodiak AK

## Executive summary

In 2003, a directed fishery for certain skate species developed in the Gulf of Alaska (GOA). Until now, skates have been managed as part of the "Other species" category under the GOA FMP, along with other potentially economically important species such as sharks, sculpins, squids, and octopi. In 2004, skates will be managed separately from the rest of the Other species category. In this document, we review available biological and fishery information on skates in the GOA, and in other areas of the world. Based on the available data, we recommend the following management measures be applied to GOA skates in 2004:

- Individual species ABC and OFL for the two current target species of the skate fishery, the big skate (*Raja binoculata*) and the longnose skate (*Raja rhina*).
- Area specific ABC and OFL for *Raja binoculata* and *Raja rhina.* The species display sensitive life history traits (large size, late maturity, and low fecundity), and the directed fishery is extremely localized, so management measures should follow suit to the extent possible.
- Genus level ABC and OFL (Gulfwide) for the *Bathyraja* species complex pending the collection of further information. These species are not yet the targets of directed fishing.

Several options are given in the assessment for calculating Tier 5 ABC and OFL, but the following are recommended (biomass is average of last three GOA trawl surveys, M estimate is 0.10):

| | Big skate | Longnose skate | all *Bathyraja* spp |
|---|---|---|---|
| E OFL | 1,079 | 1,040 | |
| C OFL | 3,284 | 2,630 | |
| W OFL | 969 | 88 | |
| Gulfwide OFL | | | 1,769 |
| E ABC | 809 | 780 | |
| C ABC | 2,463 | 1,972 | |
| W ABC | 727 | 66 | |
| Gulfwide ABC | | | 1,327 |

# Response to SSC and Council Comments

(From the December, 2000 minutes): *GOA OTHER SPECIES ABC = 11,890 mt*
*Apportionments: skates: 45%, sharks: 20%, sculpins: 30%, octopus and squid: 5%*
***The SSC supports the Plan Teams procedure for determining ABC based on Tier 5 procedures (survey biomass x 0.75 for each major taxa and summed over all taxa) and apportionment by proportionate share of ABC.*** *The SSC encourages the development of a formal FMP that allows development of standard ABCs for the species in this group.*

A Tier 5 procedure is used to determine ABC and OFL for the two target species of skates, and a similar procedure is applied to the nontarget skate species as a complex in the GOA. Information is supplied to assist in the development of a formal FMP for GOA skates based on their unique life history traits.

(Council motion from October 2003): *For the December meeting, the Council requests to have additional information provided on the biomass estimate and the incidental catch of skates in existing fisheries. This will include:*

- *Incidental catch (or best estimate) of skates by area by specific groundfish fisheries (gear and target species) in recent years (1997- 02).*
- *Incidental catch (or best estimate) of skates by the halibut fishery in recent years (1997-02).*
- *Examination of the general limitations (if any) of assessing the biomass by the trawl survey.*
- *Examination of the variability of the maximum depth surveyed in different years by the trawl survey, and how that is integrated into the biomass estimate.*
- *Examination of the sablefish survey to look at skate bycatch information to determine distribution.*

Skate incidental catch in groundfish (by area, gear, and target) and halibut fisheries 1997-2002 is estimated and discussed, as well as the relative merits and limitations of trawl survey biomass estimates in general and by year. The potential use of IPHC and Auke Bay longline surveys and limitations for skate stock assessment are discussed, and we include suggestions for incorporating additional survey information in the future.

# Introduction

### Species description and general life history traits important to management

Skates (family *Rajidae*) are cartilaginous fishes which are related to sharks. They are dorso-ventrally compressed animals with large pectoral "wings" attached to the sides of the head, and long, narrow whiplike tails (Figure 1). Potentially 12-14 species of skates in two genera, *Raja* and *Bathyraja*, are distributed throughout the eastern North Pacific and are common from shallow inshore waters to very deep benthic habitats (Eschmeyer et al., 1983). Table 1 lists the species found in the Gulf of Alaska and some life history characteristics, which are outlined in more detail below.

Skate life cycles are similar to sharks, with relatively low fecundity, slow growth to large body sizes, and dependence of population stability on high survival rates of a few well developed offspring (Moyle and Cech 1996). Sharks and skates in general have been classified as "equilibrium" life history strategists, with very low intrinsic rates of population increase implying that sustainable harvest is possible only at very low to moderate fishing mortality rates (King and McFarlane, 2003). Within this general equilibrium life history strategy, there can still be considerable variability between skate species in terms of life history parameters (Walker and Hislop, 1998). While smaller sized species have been observed to be somewhat more productive, large skate species with late maturation (11+ years) are most vulnerable to heavy fishing pressure (Walker and Hislop, 1998; Frisk et al 2001; Frisk et al 2002). The most extreme cases of overexploitation have been reported in the North Atlantic, where the now ironically named common skate *Raja batis* has been extirpated from the Irish Sea (Brander, 1981) and much of the North Sea (Walker and Hislop, 1998) and the barndoor skate *Raja laevis* has disappeared from much of its range off New England (Casey and Myers, 1998). The mixture of life history traits between smaller and larger skate species has led to apparent population stability for the aggregated "skate" group in many areas where fisheries occur, and this combined with the common practice of managing skate species within aggregate complexes has masked the decline of individual skate species in European fisheries (Dulvy et al, 2000). Similarly, in the Atlantic off New England, declines in barndoor skate abundance were concurrent with an increase in the biomass of skates as a group (Sosebee, 1998).

Several recent studies have explored the effects of fishing on a variety of skate species in order to determine which life history traits might indicate the most effective management measures for each species. While full age structured modeling is difficult for many of these relatively information poor species, Leslie matrix models parameterized with information on fecundity, age/size at maturity, and longevity have been applied to identify the life stages most important to population stability. Major life stages include the egg stage, the juvenile stage, and the adult stage (summarized here based on Frisk et al 2002). All skate species are oviparous (egg-laying), investing considerably more energy per large, well protected embryo than commercially exploited groundfish. The large, leathery egg cases incubate for extended periods (months to a year) in benthic habitats, exposed to some level of predation and physical damage, until the fully formed juveniles hatch. The juvenile stage lasts from hatching through maturity, several years to over a decade depending on the species. The reproductive adult stage may last several more years to decades depending on the species.

Age and size at maturity and adult size/longevity appear to be more important predictors of resilience to fishing pressure than fecundity or egg survival in the skate populations studied to date. Frisk et al (2002) estimated that although annual fecundity per female may be on the order of less than 50 eggs per year (extremely low compared with teleost groundfish), there is relatively high survival of eggs due to the high parental investment, and therefore egg survival did not appear to be the most important life history stage contributing to population stability under fishing pressure. Juvenile survival appears to be most important to population stability for most North Sea species studied (Walker and Hislop, 1998), and for the small and intermediate sized skates from New England (Frisk et al 2002). For the large and long lived barndoor skates, adult survival was the most important contributor to population stability (Frisk et al 2002). In all cases, skate species with the largest adult body sizes (and the empirically related large size/age at maturity, Frisk et al 2001) were least resilient to high fishing mortality rates. This is most often attributed to the long juvenile stage during which relatively large yet immature skates are exposed to fishing mortality, and also explains the mechanism for the shift in species composition to smaller skate species in heavily fished areas. Comparisons of length frequencies for surveyed North Sea skates from the mid and late 1900s led Walker and Hilsop (1998, p. 399) to the conclusion that "all the breeding females, and a large majority of the juveniles, of *Raja batis, R. fullonica* and *R. clavata* have disappeared, whilst the other species have lost only the very largest individuals." Although juvenile and adult survival may have different importance by skate species, all studies found that one metric, adult size, reflected overall sensitivity to fishing. After modeling several New England skate populations, Frisk et al (2002, p. 582) found "a significant negative, nonlinear association between species total allowable mortality, and species maximum size."

To summarize, there are clear implications for sustainable management of skates even though their populations and life histories have not been studied in as much detail as other exploited marine species. After an extensive review of population information for many elasmobranch species, Frisk et al (2001, p. 980) recommended that precautionary management be implemented especially for the conservation of large species:

> "(*i*) size based fishery limits should be implemented for species with either a large size at maturation or late maturation, (*ii*) large species (>100 cm) should be monitored with increased interest and conservative fishing limits implemented, (*iii*) adult stocks should be maintained, as has been recommended for other equilibrium strategists (Winemiller and Rose 1992)."

**Life history information for Gulf of Alaska skate species**

Information on fecundity in North Pacific skate species is extremely limited. There are one to seven embryos per egg case in locally occurring *Raja* species (Eschmeyer et al., 1983), but little is known about frequency of breeding or egg deposition for any of the local species. Similarly, information related to breeding or spawning habitat, egg survival, hatching success, or other early life history characteristics is extremely sparse for Gulf of Alaska skates (or any skates in Alaskan waters).

Slightly more is known about juvenile and adult life stages for Gulf of Alaska skates. In terms of maximum adult size, the *Raja* species are larger than the *Bathyraja* species found in the area. The big skate, *Raja binoculata*, is the largest skate in the Gulf of Alaska, with maximum sizes observed over 200 cm in the directed fishery this year (see the "Fishery" and "Survey" sections below, for details). Observed sizes for the longnose skate, *Raja rhina*, are somewhat smaller at about 165-170 cm. Therefore, the Gulf of Alaska *Raja* species are in the same size range as the large Atlantic species, the common skate *Raja batis* and the barndoor skate *Raja laevis*, which historically had estimated maximum sizes of 237 cm and 180 cm, respectively (Walker and Hislop 1998, Frisk et al 2002). The maximum observed lengths for *Bathyraja* species in the GOA range from 84-150 cm (Table 2).

At present, there is no age and growth information for any skate species in Alaska. However, vertebrae were collected from the Gulf of Alaska in 2003 from commercial fisheries and during ADF&G and NMFS trawl surveys, and a method for ageing *Raja* species is in development in British Columbia, Canada (King and McFarlane 2002), as well as at the AFSC age and growth lab. Until these collections are processed, the only age and growth information available is from a study completed off the U.S. West Coast which was limited to a size range of skates smaller than that observed off British Columbia (King and McFarlane 2002) or in Alaska. According to that study, Californian female big skates mature at 12 years (1.3-1.4m), and males mature at 7-8 years (1-1.1 m), but the maximum sizes estimated were only 170 cm for females and 140 cm for males (Zeiner and Wolf, 1993). Maximum size from fisheries off California is reported to be 2.4 m, with 1.8m and 90 kg common (Martin and Zorzi, 1993). The longnose skate, *Raja rhina*, achieves a smaller maximum length of about 1.4 m in California, and matures between ages 6 (males) and 9 (females). Maximum age reported for the longnose skate was 13 years, but again the maximum estimated size seemed small at 107 cm for females and 95 cm for males (Zeiner and Wolf, 1993). No information was found on any *Bathyraja* species life history. Age, growth, and maturity studies of the predominant *Bathyraja* species in the Bering Sea, *Bathyraja parmifera* the Alaska skate, were initiated in 2003, and may provide information helpful to management of GOA species in the future.

Because no other life history parameters are currently available for Gulf of Alaska skate species besides maximum size, we use two methods to infer the parameters important to management which are age/size at maturity and natural mortality. First, we use Frisk et al's (2001) empirical method to estimate length at maturity from maximum length for all skate species where data are available (Table 2). Second, we assumed that the largest skate species in the GOA would share the general characteristics found for other large elasmobranchs worldwide and some of the specific characteristics of the large Atlantic species, *Raja batis* and *R. laevis*. Frisk et al (2002) derived an estimate of natural mortality of 0.09 using Hoenig's (1983) method for barndoor skates which was based on the longevity of common skates of approximately 50 years. In addition, Frisk et al (2001) estimated that on average, medium sized (100-199 cm) elasmobranchs have a potential rate of population increase around 0.21. The intrinsic rate of increase parameter (*r)* from the logistic growth model is related to the exploitation rate F at MSY and therefore the overfishing limit (OFL) as defined by the North Pacific Fishery Management Council could be specified as follows:

$$F_{MSY} = F_{OFL} = r/2$$

This relationship is derived from the logistic growth equation (see e.g. Murray 1989, chapter 1). If the potential rate of population increase estimated by Frisk et al (2001) for medium sized elasmobranchs is viewed as analogous to the logistic model parameter *r*, this would define $F_{MSY} = F_{OFL}$ =(0.21/2)=0.105. Therefore, for the purposes of calculating a Tier 5 $F_{OFL}$ based on natural mortality (*M*), *M* was estimated to be approximately 0.10 for the big skate *Raja binoculata* and the longnose skate *R. rhina.* Because little is known about *Bathyraja* species anywhere, a precautionary approach was applied in estimating *M* for these species in the Gulf of Alaska; it is estimated to be 0.10 until further information can be collected, although it is possible that these species are slightly more productive than the larger *Raja* species.

**Management of skates in the Gulf of Alaska**

Since the beginning of domestic fishing in the late 1980s up through 2003, all species of skates in the Gulf of Alaska have been managed under the “Other species” FMP category. The Other species category was established to monitor and protect species groups that are not currently economically important in North Pacific groundfish fisheries, but which were perceived to be ecologically important and of potential economic importance as well. Although the composition of this category has varied over the course of FMP management, the current configuration of sharks, skates, sculpins, squid, and octopus has been relatively stable. An aggregate Total Allowable Catch (TAC) limits the catch of species in this category. TAC of GOA other species is established based on 5% of the sum of target species TACs each year, although a preliminary stock assessment was conducted for GOA other species in 1999 (Gaichas et al. 1999).

In 1999, FMP Amendments 63/63 were initiated to remove the shark and skate species groups from other species in both the BSAI and GOA to better protect these vulnerable, long-lived species (NPFMC 1999). Based on the 1999 stock assessments for other species, the Plan Teams recommended that all other species be considered in an expanded FMP amendment to establish TACs at the species group level. While this amendment was being revised, the Council recommended to NMFS that Other species be placed on “bycatch only” status to prevent a directed fishery from developing in the interim. NMFS determined that it did not have regulatory authority for such an action, so aggregate other species TACs have remained in place up through 2003 in the BSAI and in the GOA despite efforts to limit directed fisheries and develop more protective management within this category. Final action on the revised plan amendments to re-define the ABC, OFL and TAC setting process for skate species in the GOA are scheduled for 2003 as a result of a developing target fishery for two skate species (see below). The remaining species in the GOA Other species category continue to be managed under an aggregate TAC set at 5% of the sum of all target species TACs. The NPFMC has appointed a committee to address management of nontarget species and species complexes.

## The fishery

Until 2003, skates were primarily caught as bycatch in both longline and trawl fisheries directed at Pacific halibut and other groundfish. (In this assessment, “bycatch” means incidental or unintentional catch regardless of the disposition of catch—it can be either retained or discarded. We do **not** use the Magnuson Act definition of “bycatch,” which always implies discard.) When caught as bycatch, skates may be discarded (and may survive depending upon catch handling practices) although skates caught incidentally are sometimes retained and processed. A directed skate fishery developed in the Gulf of Alaska in 2003, and skates support directed fisheries in other parts of the world (Agnew et al 1999, NMFS 2000, Martin and Zorzi 1993). There has been interest in developing markets for skates in the Gulf of Alaska (J. Bang and S. Bolton, Alaska Fishworks Inc., 11 March 2002 personal communication), and the resource was quite economically valuable to the participants in 2003.

Here, we first summarize skate catch information from the GOA from 1997-2002, years which presumably represent skates caught primarily as bycatch. Then we present all available information on the fishery in 2003, which represents a mixture of bycatch and directed fishing for skates. We hope that this information can be used to help the Council determine how much skate catch is "natural" bycatch in other groundfish fisheries and therefore how much more skate catch can be allowed in a new directed fishery within the ABCs recommended for each species and species group here.

**Skate incidental catch in groundfish and halibut fisheries, 1997-2002**

Incidental catch of skates (all species in aggregate) in federal groundfish fisheries between 1997-2002 (Tables 3-4) was estimated as follows (this is the same method which has been used to estimate catch of all nontarget species in both the GOA and the BSAI). Because annual nontarget species catches are either reported in aggregate in the official Blend catch database or are not reported at all, catches by species group or individual species must be estimated using data reported by fishery observers. Catches for all non-target species were estimated at the lowest practical taxonomic level for the recent domestic fishery, 1997 - 2002, by simulating the Regional Office's blend catch estimation system as follows. Target fisheries were assigned to each vessel / gear / management area / week combination based upon retained catch of allocated species, according to the same algorithm used by the Regional office. Observed catches of other species (as well as forage and non-specified species) were then summed for each year by target fishery, gear type, and management area. The ratio of observed other species group catch to observed target species catch was multiplied by the blend-estimated target species catch within that area, gear, and target fishery.

Estimation of individual species catches within the other species complex depends on the level of identification of those species in the catch. Skates were almost always recorded as "skate unidentified", with very few exceptions between 1990-2002. At that time, Observers were instructed to devote resources to higher-priority target species and prohibited species data collection. However, the Observer Program initiated a skate species identification special project in 2003. Based on the success of this project, all observers will be instructed to identify skates to species in 2004. This represents a major improvement to data available for stock assessment.

The accuracy of catch estimates for groups or species within the other species complex also depends on the level of observer coverage in a given fishery (no observers, no catch estimates). Observer coverage requirements are based upon vessel size, such that vessels greater than 125 ft in length carry an observer on all fishing days, vessels 60-125 ft in length carry an observer for 30% of fishing days, and vessels under 60 ft in length are not required to carry observers. In general, larger vessels fish in the Bering Sea, such that observer coverage levels in some fisheries approach 100%. Our calculations for 1997-2001 suggest that the BSAI region has approximately 70-80% observer coverage overall. Due to the size distribution of vessels fishing in the Gulf of Alaska, approximately 20-25% of groundfish fishery operations (not including Pacific halibut) are observed. Some GOA target fisheries (ie. rockfish) are prosecuted on larger vessels with 100% observer coverage. Therefore, in making these catch estimates, we are assuming that other species catch in general and skate catch aboard observed vessels is representative of other species catch aboard unobserved vessels throughout Alaska. Because observer assignment to vessels in the 30% coverage class is nonrandom, there is a possibility that this assumption is incorrect.

In 2002, we note that the catch estimate for skates gulfwide appears to have doubled or tripled relative to previous years (Tables 3-4). Most of this increase comes from one sector of the fleet, small longliners in the Central GOA target fishery for Pacific cod. The catch estimate for this entire sector of the fleet is based on observations aboard a single vessel for a short period of time. The species composition of the catch aboard this vessel resembles that of a vessel targeting Pacific halibut, not Pacific cod, but due to database structure and the conventions of designating target fisheries the catch was assigned to the cod target. This resulted in a catch of skates which was greater than that of cod (but still only about a third of halibut catch) being expanded to the (otherwise apparently unobserved) total cod catch in that sector and area in the final estimate. This estimate remains in place as the best available information, and is consistent in method with estimates from previous years, but illustrates the potential pitfalls of nontarget species catch estimation when observer coverage is limited and not assigned at random. It may also provide some insight into the bycatch of skates in directed fisheries for Pacific halibut.

This year the NPFMC requested that the International Pacific Halibut Commission (IPHC) provide estimates of skate bycatch in directed Pacific halibut fisheries. There is no observation of these fisheries at sea, so the IPHC provided estimates of skate bycatch in the fisheries based on skate bycatch observed during IPHC longline surveys for halibut (Table 5). Because skate catches in Table 5 are estimated from survey catch and not directly from fishery information, these skate bycatch numbers are independent of those reported from ADF&G fish tickets, but should not be summed with skate catches reported on fish tickets to avoid double counting. Figure 2 shows how IPHC areas correspond to NPFMC management areas. In general, it appears that directed fisheries for Pacific halibut take a substantial amount of skates annually as bycatch, on the order of 1,000 metric tons or more per year. Steps should be taken to quantify this bycatch to species, as it is equivalent to at least half the magnitude of groundfish skate bycatch.

The landed portion of skate catch is recorded in the ADF&G fish ticket database. Fish ticket data provides complementary information to observer data, in that it is more comprehensive in terms of landings overall but may underestimate at sea discards. Skate landings in aggregate are shown for 1988-2003 in Table 6, discards reported on fish tickets in Table 7, and catch by gear and area (federal vs state waters) in Tables 8-9. We note that the fish ticket information clearly reflects the target fishery that developed in 2003, that the target fishery occurred mostly in federal waters, and in particular the prevalence of longline gear in the target fishery (see further discussion below).

The observed catch and landings of skates have shown consistent spatial patterns between 1997 and 2002, suggesting that skates are associated with certain areas and or habitats in the GOA and may be found there predictably, especially since there was little to no targeting of skates in these years. Figures 3-8 depict catch of all skate species in aggregate from two perspectives. The top portion of each figure shows the observed extrapolated weight of skates caught each year, regardless of whether they were retained or discarded. The bottom portion of each figure shows the origin of landed skates from ADF&G fish tickets. Each source of data has limitations, (ie the observer data on top does not account for unobserved vessels or trips and the fish ticket data below likely underrepresents discards) but taken together the maps provide insight into areas of historically high skate abundance. The overall implication of these maps is that skate catch has occurred consistently in “hotspots.” This suggests that the species distributions may be constant over time in space and that survey distributions might be useful to predict catch. This also implies that catch is concentrated in space, so the potential for localized depletion is high. While the degree of mixing among these areas is unknown, it seems prudent to have management measures that sustain these concentrations until more is known about stock structure.

Although there are no direct estimates of skate bycatch by species in any fisheries 1997-2002, aggregated skate catch can be proportioned to species by fishery using spatial information combined with survey estimates, as follows (a full discussion of survey information is found below, under “Resource surveys”). Observed hauls with skate catch were assigned to GOA trawl survey strata according to the latitude and longitude of trawl haul or fixes gear set retrieval. Then, all catch that was identified as “skate unidentified” was proportioned to species using the average (1999-2003 surveys) skate species proportions for that survey strata. These survey years were selected because we are most confident in skate species identification for surveys conducted since 1999. Skate species composition estimates for survey strata in the Western and Central GOA down to 500 m depth were based on three surveys (1999, 2001, and 2003), while the Eastern GOA and strata deeper than 500 m were based only on the 1999 and 2003 surveys. The total skate catch estimates reported by gear and area in Table 3 were apportioned to species by the skate species composition estimated for the observed skate catch by survey strata. This method assumes that skate species composition by survey strata has remained constant over the late 1990s, that summer survey distributions are representative of skate species distributions throughout the year, and that observed skate catch is representative of unobserved skate catch by gear type and area. The resulting catch estimates by skate species should be considered rough approximations subject to numerous assumptions, but nevertheless are the best available information on skate catch by species (Table 10). This estimation method suggests that approximately 44% of historical GOA skate bycatch on average has been longnose skates, about 26% has been big skates, and the remaining 30% has been *Bathyraja* species.

**Skate catch in the 2003 directed fishery**

The development of a directed skate fishery in 2003 has created new catch estimation problems. A large proportion of the directed fishing is prosecuted on vessels less than 60 ft in length, so there is no at sea observer coverage of the fleet. These vessels delivered skates to plants that process monthly volumes of catch that are also too low to require observer coverage. Therefore, this multispecies fishery is currently developing without the appropriate monitoring levels established for federal groundfish management in Alaska. Although all observers are trained and will identify skates to species starting in 2004, this will be of little use if vessels and plants where the directed fishery is occurring are largely without observer coverage (as was the case in 2003). Fortunately, the extra sampling effort that was voluntarily contributed by both ADF&G port samplers and NMFS staff in Kodiak has allowed the estimation of catch by species in the directed fishery for 2003. Clearly, a more formal program to sustain these efforts is required given the standard workload of Kodiak staff in both agencies. A formal approach to sampling the skate fishery should be developed if the target fishery is to be allowed to continue in the future. One way to do this would be with dedicated port sampling staff, who could either sample deliveries of skates as they arrived, or could sample already processed skate products for species composition using genetic species identification techniques recently developed at AFSC by Mike Canino and Ingrid Spies.

Catch estimates for skates in the GOA in 2003 are incomplete, as fishing still continues. The development of the fishery is evident in the catch distribution maps; there is considerable contrast between maps for 1997-2002 and those for 2003. The areas of high skate density which appeared in observed catch maps 1997-2002 (Figs 3-8) surround Kodiak Island, and are the areas where the directed fishery was most active in 2003, as Figure 9 indicates. To date, total skate catch is still a combination of incidental in groundfish and halibut fisheries and directed catch in skate fisheries. Catch by species estimated from observer data is likely to be mostly incidental catch, while the limited sampling of landed catch reflects the otherwise unobserved target fishery. Estimating catch from observer data by the method described above that was used in 1997-2002 is not possible until catches for an entire calendar year are finalized, and so has not been attempted here. In contrast to previous years, up to 37% of observed skate catch was identified to species in 2003, a result of the skate species identification project implemented this year. The proportion of skate species in each category based on observed catch to date is reported in the last column of Table 10; catches are not expanded to tons for reasons outlined above. Estimates of halibut fishery bycatch for 2003 are likewise unavailable, although some information is available from the fish ticket database on skate catch in the halibut fishery.

The estimates of landings from the ADF&G fish ticket database are the best current estimate of skate catch (Tables 6-9), which is likely an underestimate of total catch as if probably underestimates at sea discards. We firsr use the difference between the average catch reported on fish tickets by area 1997-2002 and the catch reported to date for 2003, to approximate the catch in the targeted skate fishery for 2003 (Table 11(a)). This method suggests that a total of 2,629 t of skates were taken in the directed fishery to date, with 2,498 t coming from the Central GOA. We also attempt to distinguish directed skate catch from skate catch landed as bycatch by using information on Maximum Retainable Allowances (MRAs) contained in fish tickets. Those fish tickets where skates were over the MRA of 20% could be considered the directed skate fishery, whereas those listed in the Pacific cod target with retention of skates at 20% or less of cod catch could be considered landed bycatch of skates. This may help distinguish skate targeting from incidental retention; Gulfwide target fishery skate catch estimated by this method is 2,743 t (Table 11(b)), very similar to that estimated by the alternative method above.

The distinction between skate species was not recorded on fish tickets, especially because there were not species codes for all species landed in the fishery (we recommend that this be corrected for next year). However, there was some evidence for preferential retention of *Raja* species and at sea discard of *Bathyraja* species if they could be distinguished (Rob Swanson, July 2003 skipper and crew interviews dockside in Kodiak). Species composition of landed skate catch comes from dockside sampling by ADF&G and NMFS staff in Kodiak. The early fishery in February and March was sampled by ADF&G port samplers; this sampling is summarized in Appendix 1. Based on this sampling, the directed skate fishery was landing approximately 79% big skates (of which 78% were female), and 21% longnose skates (which were 52% female). Sampling later in the year by NMFS staff in Kodiak resulted in similar, if not more extreme species and sex compositions. Sampling indicated that 95% of hook and line landings and 92% of trawl landings were big skates (of which 80% and 90% were female, respectively). Longnose skates composed 4 and 6% of hook and line and trawl landings, respectively, and landings for this species were 53% and 35% female by gear type. Table 12 summarizes the results of sampling during summer months. It seems clear from these samples that the directed skate fishery seeks large individuals, which are predominantly female big skates. Size sampling of the delivered hook and line catches in conjunction with two at sea observer samples of trawl skate catch appears to corroborate this conclusion (see Figure 14). Applying the species compositions estimated from dockside sampling to an approximate estimate of 2,700 t total skate catch in the 2003 directed fishery (see above), directed catch of big skates in 2003 would be between 2,160 t (80%) and 2,430 t (90% of catch), catch of longnose skates would be between 135 and 340 t, and *Bathyraja* species catch would be the remainder, up to 135 tons.

## Resource Surveys

There are several potential indices of skate abundance in the Gulf of Alaska, including longline and trawl surveys. Unfortunately, the sablefish longline survey conducted by the NMFS Auke Bay lab does not identify skates to species at present and is therefore of limited use for stock assessment. Although many skates are identified to species on IPHC longline surveys, sampling of non-halibut species during these surveys is restricted in scope and nonrandom, so this survey is also of limited use for skate stock assessment. For this assessment, we use the NMFS summer bottom trawl surveys 1984-2003 as our primary source of information on the biomass and distribution of the major skate species. Bottom trawl surveys are generally considered reliable estimators of skate biomass for trawlable areas. Preliminary work on skate escapement under bottom trawl footropes was initiated this year in the EBS, and results should be available soon to evaluate the assumptions about survey catchability for skates (here assumed to equal 1).

Survey trends by species between 1984 and 2003 are displayed in Figure 10 for the entire GOA. A breakdown of biomass estimates for the Eastern (management areas 640-650), Central (620-630) and Western (610) GOA for 1984-2003 are given in Table 13. Note that not all surveys covered the same areas and depths; the 1990, 1993, and 1996 surveys covered depths to 500 m, the 1984, 1987 and 1999 surveys covered depths to 1000 m, and the 2003 survey covered to 700 m. Due to limited resources, the

2001 survey did not extend to the Eastern GOA and went only to 500 m in the Central and Western GOA. Therefore the observed trends in skate species biomass may reflect a combination of actual population dynamics and survey coverage. It is possible that what appears to be an increase in skate biomass overall between the early and late 1990s is simply the result of sampling more (deeper) skate habitat in the late 90s combined with differences in survey strategy between the cooperative surveys conducted during the 1980s and the NMFS surveys of the 1990s. Similarly, species identification of skates was problematic in early survey years (reflected in the relatively higher proportion of biomass in the "skate unidentified" category) and became most reliable for surveys starting in 1999. (This is why we recommended quotas based on trawl survey biomass estimates from 1999-2003, see "Harvest Recommendations" section).

Despite inconsistencies in survey coverage and species identification, it is clear that big skates *Raja binoculata* and longnose skates *Raja rhina* dominate the skate biomass in the GOA. *Bathyraja* species compose about a third of total GOA skate biomass, with the majority of these being the Aleutian skate *Bathyraja aleutica*, followed by the Bering skate *Bathyraja interrupta*, and then by the Alaska skate *Bathyraja parmifera* (Figure 10). This contrasts greatly with the situation in the Eastern Bering Sea, where *Bathyraja parmifera* dominates skate biomass by more than an order of magnitude over any other skate species, see BSAI Other species SAFE.

Skate species composition also differs by area, as has been found in the North Sea (Walker and Hislop 1998). Figure 11 compares the gulfwide skate biomass by species with species compositions specific to the Western, Central, and Eastern GOA from the 2003 GOA bottom trawl survey. We note that the center of abundance for big and longnose skates is in the Central GOA, with somewhat lower biomass estimated for the Eastern GOA and much lower biomass for the Western GOA (Fig 11). *Bathyraja* species abundance increases from East to West in the GOA. The Central GOA is not only the center of skate abundance, but also diversity according to the 2003 survey.

The length frequencies of predominant skate species are presented in Figures 12-14. In Figure 12 the overall length composition of the biomass dominant big skate *Raja binoculata* is given as estimated by both the ADF&G trawl survey and the NMFS trawl survey in the Central GOA for 2003. Results of the two surveys are similar in terms of overall length range sampled (~40 cm to ~200 cm). The two surveys should provide complementary as well as redundant information on big skates, given that they survey the same areas of the GOA at the same time, but the ADF&G survey is generally nearer to shore than the NMFS trawl survey. In future assessments, a more formal method of integrating results from the two surveys should be explored for the more shallow and nearshore *Raja* species in the GOA. In addition, information from IPHC surveys and the Auke Bay longline survey directed at sablefish could be helpful in future assessments if skate species identification can be standardized between surveys.

Figure 13 illustrates survey size compositions for big skates *Raja binoculata* and longnose skates *R. rhina* for Gulfwide populations separated by sex. It is apparent that female big skates attain much larger sizes (190-200 cm) than males of the same species (150 cm), while female longnose skates are only slightly larger than males (160 vs 150 cm, respectively). The pattern holds at the center of abundance for both *Raja* species in the Central GOA (Figure 14). The only other year of survey length composition data available for GOA skates is 2001. While not shown here, the patterns of length by sex for each species were very similar in the Central GOA (the Eastern GOA was not sampled in 2001 and Raja species are much rarer in the Western GOA, leading to more noise in the length composition estimates for that area).

Figure 15 compares the big skate length frequency from the 2003 summer trawl survey with some limited data collected during the same time period from skate fisheries. It is apparent that both longline catches and trawl catches of big skate were disproportionately of large animals, and were predominated by large females as data presented above for the target fishery suggested.

# Harvest Recommendations for GOA skates

Information available suggests that bycatch of skates in the Gulf of Alaska is predominantly longnose skates and big skates, while directed catch of skates is predominantly large female big skates. If all of the evidence gathered from skate fisheries worldwide is reliable, then large skate species like big skates and longnose skates are likely to be vulnerable to overfishing, and would require long recovery times if overfished. Furthermore, as a worst case scenario, they may be vulnerable to severe localized depletion if subjected to heavy fishing pressure. While it appears that historical incidental catch of skates in groundfish and halibut fisheries does not represent heavy fishing pressure (stable to increasing survey trends between 1984-2003 support this assertion), the incidental catch combined with a directed skate fishery targeting the largest individuals of the largest species might result in excessive fishing mortality and negative population effects if improperly managed. The spatial concentration of the directed fishery in particular suggests that management should guard against localized depletion of skates, especially when little is known of migratory habits or population structure for any Alaskan skate species.

We recommend the following management measures be applied to GOA skates in 2004:

- Individual species ABC and OFL for the two current target species of the skate fishery, the big skate (*Raja binoculata*) and the longnose skate (*Raja rhina*).
- Area specific ABC and OFL for *Raja binoculata* and *Raja rhina.* The species display sensitive life history traits (large size, late maturity, and low fecundity), and the directed fishery is extremely localized, so management measures should follow suit to the extent possible.
- Genus level ABC and OFL (Gulfwide) for the *Bathyraja* species complex pending the collection of further information. These species are not yet the targets of directed fishing.

Several options are given in the assessment for calculating Tier 5 ABC and OFL (Table 14), but the following are recommended (biomass is average of last three GOA trawl surveys where species identification was best, M estimate is 0.10 for all species as explained in the introduction):

| | **Big skate** | **Longnose skate** | **all *Bathyraja* spp** |
|---|---|---|---|
| E OFL | 1,079 | 1,040 | |
| C OFL | 3,284 | 2,630 | |
| W OFL | 969 | 88 | |
| Gulfwide OFL | | | 1,769 |
| E ABC | 809 | 780 | |
| C ABC | 2,463 | 1,972 | |
| W ABC | 727 | 66 | |
| Gulfwide ABC | | | 1,327 |

Table 15 compares the results of the spatial species catch estimation process for incidental skate catch in groundfish fisheries (shown in Table 10 for 1997-2002) with the species and area specific management measures recommended for 2004. To get a more comprehensive picture of skate catch relative to proposed management measures, we attempted to combine information from groundfish fisheries, halibut fisheries, and directed skate fisheries. Skate catches in Pacific halibut fisheries are added to groundfish incidental catches for each year by assuming species composition in halibut fisheries followed the average proportions observed in groundfish longline fisheries by area in 1997-2002. We summed estimated average incidental skate catches by species over 1997-2002 in both groundfish and halibut fisheries to estimate incidental skate catch in 2003 and then added the estimates of directed fishery catch to arrive at a total catch estimate for 2003 to compare with proposed management measures for 2004 (Table 16).

It seems clear that the proposed skate management would not impact groundfish fisheries if they continued to catch skates as observed in 1997-2002, and would allow a limited target fishery to continue for big and longnose skates in the Central GOA. However, this target fishery would have to be smaller in scale than the one that developed in 2003 to stay within the proposed ABCs for big skates in the Central GOA, and/or incidental big skate catch in groundfish and halibut fisheries would have to be reduced (Table 16). Furthermore, bycatch in the directed fisheries for Pacific halibut should be monitored directly to ensure that it does not contribute to overexploitation of skate species. We note that skate catch in past years has been unconstrained and therefore incidental catches may be reduced from observed levels if groundfish and halibut fisheries actively avoid skate catch. We also assume 100% mortality for incidentally caught skates, which may be reduced if careful release methods are employed.

Given the potentially sensitive nature of skate populations, especially large sized species such as the big skate and longnose skate, fishery management should guard against local overexploitation to the extent possible. Area specific OFLs are suggested as a gross measure to achieve this management objective; better options would include more specific localized catch restrictions once a better understanding of population structure in space is achieved, or size limits in directed skate fisheries that ensured only mature individuals were retained and that an appropriate proportion of adult females remained in the population. In addition, information on *Bathyraja* species should be closely monitored to ensure that target fisheries do not expand to these poorly understood species before basic life history information can be collected to ensure effective management.

## Acknowledgements

Without the early warning of the skate fishery development provided by ADF&G and NMFS staff in Kodiak there would be little information to base this assessment on, and the first author would have remained clueless in Seattle.  Many ADF&G port samplers and ADF&G and NMFS survey staff participated in collecting skate fishery and life history information this year, despite already full workloads.  We thank the other participants in the hastily convened “skate working group” who are not already authors on this assessment: Jerry Hoff, Beth Matta, and Liz Chilton.

We are grateful to participants in the 2003 skate fishery who provided information dockside and who permitted sampling of catches at plants which normally do not have observer coverage. We encourage continued exchange of information so that the skate fishery may develop sustainably.

We must acknowledge both fishery observers and the staff of the North Pacific Groundfish Observer Program for working to overcome logistical difficulties and an already formidable workload to develop practical and reliable skate identification protocols for use at sea, and for implementing skate identification for all observers mid year in 2003, when it became obvious that the skate fishery was expanding. We also appreciate the continued commitment to full identification of all observed skate catch for 2004, which will greatly improve management for these species.

Many different offices and agencies have responded efficiently to requests for help and information related to the skate assessment. The North Pacific Council and NMFS AK Regional Office staff, especially Jane DiCosimo, Ben Muse, and Melanie Brown, continue to work tirelessly on the analyses required to implement new management measures for skates in a timely manner.  We appreciate the quick response of the IPHC staff, in particular Heather Gilroy, who provided estimates of skate catch based on longline survey information.  The AFSC Age and Growth has agreed to take on the additional task of developing ageing methods for skate vertebrae.  The AFSC RACE division initiated catchability experiments this year for skates and other nontarget species. We look forward to continued improvements in assessment information resulting from the combined efforts of these dedicated people. Thank you.

# References

Agnew, D.J., C.P. Nolan, J.R. Beddington, and R. Baranowski, 2000. Approaches to the assessment and management of multispecies skate and ray fisheries using the Falkland Islands fishery as an example. Can. J. Fish. Aquat. Sci. 57: 429-440.

Allen, M.J., and G.B. Smith, 1988. Atlas and zoogeography of common fishes in the Bering Sea and northeastern Pacific. NOAA Technical Report NMFS 66, 151 pp.

Alverson, D.L., and W.T. Pereyra, 1969. Demersal fish explorations in the northeastern Pacific Ocean: An evaluation of exploratory fishing methods and analytical approaches to stock size and yield forecasts. J. Fish. Res. Bd. Canada 26: 1985-2001.

Brander, K., 1981. Disappearance of common skate *Raja batis* from Irish Sea. Nature 290: 48-49.

Casey, J.M. and R.A. Myers, 1998. Near extinction of a large, widely distributed fish. Science 281(5377):690-692.

Dulvy, N.K., J.D. Metcalfe, J. Glanville, M.G. Pawson, and J.D. Reynolds, 2000. Fishery stability, local extinctions, and shifts in community structure in skates. Conservation Biology 14(1): 283-293.

Eschmeyer, W.N., E.S. Herald, and H. Hammann, 1983. A field guide to Pacific coast fishes of North America. Houghton Mifflin Co., Boston: 336 pp.

Frisk, M.G., T. J. Miller, and M. J. Fogarty, 2001. Estimation and analysis of biological parameters in elasmobranch fishes: a comparative life history study. Can. J. Fish. Aquat. Sci. 58: 969-981.

Frisk, M. G. , T. J. Miller, and M. J. Fogarty, 2002. The population dynamics of little skate *Leucoraja erinacea*, winter skate *Leucoraja ocellata*, and barndoor skate *Dipturus leavis*: predicting exploitation limits using matrix analysis. ICES J. Mar. Sci. 59: 576-586.

Gaichas, S., J. Ianelli, and L. Fritz, 1999. Other species considerations for the Gulf of Alaska.

Hoenig, J.M., 1983. Empirical use of longevity data to estimate mortality rates. Fish. Bull. 82(1): 898-902.

Ishihara, H. and R. Ishiyama, 1985. Two new North Pacific skates (Rajidae) and a revised key to *Bathyraja* in the area. Jpn. J. Ichthyol. 32(2): 143-179.

King, J. R., and G. A. McFarlane, 2002. Preliminary results of Big Skate (*Raja binoculata*) Age Determination Project. Unpub. Man. DFO.

King, J.R., and G.A. McFarlane, 2003. Marine fish life history strategies: applications to fishery management. Fish. Man. and Ecology, 10: 249-264.

Martin, L. and G.D. Zorzi, 1993. Status and review of the California skate fishery. In Conservation biology of elasmobranchs (S. Branstetter, ed.), p. 39-52. NOAA Technical Report NMFS 115.

McEachran, J.D., and K.A. Dunn, 1998. Phylogenetic analysis of skates, a morphologically conservative clade of elasmobranchs (Chondrichthyes: Rajidae). Copeia, 1998(2), 271-290.

McEachran, J.D. and T. Miyake, 1990a. Phylogenetic relationships of skates: a working hypothesis (Chondrichthyes: Rajoidei). In Elasmobranchs as living resources: advances in the biology, ecology, systematics, and the status of the fisheries (H.L. Pratt, Jr., S.R. Gruber, and T. Taniuchi, eds.), p. 285-304. NOAA Technical Report NMFS 90.

McEachran, J.D. and T. Miyake, 1990a. Phylogenetic relationships of skates: a working hypothesis (Chondrichthyes: Rajoidei). In Elasmobranchs as living resources: advances in the biology, ecology, systematics, and the status of the fisheries (H.L. Pratt, Jr., S.R. Gruber, and T. Taniuchi, eds.), p. 285-304. NOAA Technical Report NMFS 90.

Moyle, P.B., and J.J. Cech, Jr., 1996. Fishes, an introduction to ichthyology (Third edition). Prentice Hall: New Jersey, 590 pp.

Murray, J.D., 1989. Mathematical Biology. Springer-Verlag: New York. 767 pp.

Musick, J.A., S.A. Berkeley, G.M. Cailliet, M. Camhi, G. Huntsman, M. Nammack, and M.L. Warren, Jr., 2000. Protection of marine fish stocks at risk of extinction. Fisheries 25(3):6-8.

Nelson, J. S., 1994. Fishes of the world, Third edition. John Wiley and Sons, Inc., New York: 600 pp.

NMFS 2000. Skate complex. In Draft 30th Northeast Regional Stock Assessment Workshop (30th SAW), Stock assessment review committe (SARC) consensus summary of assessments, p. 7-173.

NMFS PSEIS 2001. Draft Programmatic Environmental Impact Statement.

Orlov, A.M., 1998. The diets and feeding habits of some deep-water benthic skates (Rajidae) in the Pacific waters off the northern Kuril Islands and southeastern Kamchatka. Alaska Fishery Research Bulletin 5(1): 1-17.

Orlov, A.M., 1999. Trophic relationships of commercial fishes in the Pacific waters off southeastern Kamchatka and the northern Kuril Islands. Pages 231-263 in Ecosystem Approaches for Fishery Management, Alaska Sea Grant College Program AK-SG-99-01, University of Alaska Fairbanks, 756 pp.

Sosebee, K., 1998. Skates. In Status of Fishery Resources off the Northeastern United States for 1998 (Stephen H. Clark, ed.), p. 114-115. NOAA Technical Memorandum NMFS-NE-115.

Thompson, G.G., 1993. A proposal for a threshold stock size and maximum fishing mortality rate. Pages 303-320 in Risk evaluation and biological reference points for fisheries management (S.J. Smith, J.J. Hunt, and D. Rivard, eds.). Can. Spec. Publ. Fish. Aquat. Sci. 120, 440 pp.

Walker, P.A., and R. G. Hislop, 1998. Sensitive skates or resilient rays? Spatial and temporal shifts in ray species composition in the central and north-western North Sea between 1930 and the present day. ICES J. Mar Sci., 55: 392-402.

Winemiller, K.O., and K.A. Rose, 1992. Patterns of life history diversification in Nortn American fishes: implications for population regulation. Can. J. Fish. Aquat. Sci. 49: 2196-2218.

Zeiner, S.J. and P. Wolf, 1993. Growth characteristics and estimates of age at maturity of two species of skates (*Raja binoculata* and *Raja rhina*) from Monterey Bay, California. In Conservation biology of elasmobranchs (S. Branstetter, ed.), p. 39-52. NOAA Technical Report NMFS 115.

**Table 1.** Life history information available for BSAI and GOA skate species.

| Species | Common | Max Length (cm)[1] | Max Age | Age Length Mature[2] | Feeding mode[3] | n / egg case[1] | Depth range (m)[4] | Est. of M |
|---|---|---|---|---|---|---|---|---|
| ***Raja binoculata*** | **big skate** | **180-240** | **?** | **8-12 yrs 109-130 cm** | **predatory?[1]** | **1-7** | **3-800[5]** | **0.10** |
| ***Raja rhina*** | **longnose skate** | **165*** | **?** | **7-10 yrs 74-100 cm** | **?** | **1** | **25-675[5]** | **0.10** |
| ***Bathyraja interrupta*** | **Bering skate** | **86** | **?** | **?** | **benthophagic** | **1** | **50-1380** | **0.10** |
| ***Bathyraja tanaretzi*** | **mud skate** | **70*** | **?** | **?** | **?** | **1** | | **0.10** |
| ***Bathyraja trachura*** | **black skate** | **89** | **?** | **?** | **?** | **1** | **800-2050** | **0.10** |
| ***Bathyraja parmifera*** | **Alaska skate** | **61-91, 113*** | **?** | **?** | **predatory** | **1** | **25-300** | **0.10** |
| ***Bathyraja aleutica*** | **Aleutian skate** | **120-150** | **?** | **?** | **predatory** | **1** | **300-950** | **0.10** |
| ***Bathyraja lindbergi*** | **commander skate** | **93*** | **?** | **?** | **?** | **1** | **175-950** | **0.10** |
| ***Bathyraja maculata*** | **whiteblotched skate** | **120*** | **?** | **?** | **predatory** | **1** | **175-550** | **0.10** |
| ***Bathyraja minispinosa*** | **whitebrow skate** | **82*** | **?** | **?** | **benthophagic** | **1** | **100-1400** | **0.10** |
| ***Bathyraja violacea*** | **Okhotsk skate** | **150*** | **?** | **?** | **benthophagic** | **1** | **25-500** | **0.10** |

**[1]Eschemeyer, 1983 (assuming that *B. kincaidii* = *B. interrupta*) and *species id notes by Jay Orr (AFSC)**
**[2]Zeiner and Wolf, 1993.**
**[3]Orlov, 1998 & 1999 (benthophagic eats mainly amphipods, worms. Predatory diet primarily fish, cephalopods)**
**[4]McEachran and Miyake, 1990b**
**[5]Allen and Smith, 1988**

**Table 2. Length at maturity for each species equals max length times 0.71 plus 5.17 and the regression r squared was .89, the best fit of anything in the paper (Frisk et al 2001). Max length is from NMFS trawl survey sampling in 2003.**

| | | 2003 NMFS GOAsurvey max length (mm) | Frisk et al 2001 est length maturity (mm) |
|---|---|---|---|
| Alaska skate | *Bathyraja parmifera* | 1350 | 963.67 |
| Aleutian skate | *Bathyraja aleutica* | 1500 | 1070.17 |
| Bering skate | *Bathyraja interrupta* | 840 | 601.57 |
| big skate | *Raja binoculata* | 1920 | 1368.37 |
| longnose skate | *Raja rhina* | 1670 | 1190.87 |
| whiteblotched skate | *Bathyraja maculata* | 1210 | 864.27 |

**Table 3. Estimated annual skate catch (all species) in tons by gear and area, 1997-2002**

| GOA area | gear | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|
| Central | hook n line | 552 | 485 | 416 | 1,815 | 702 | 4,834 |
| | pot | 1 | 0 | 0 | 0 | 0 | 0 |
| | trawl | 2,078 | 961 | 833 | 857 | 778 | 983 |
| Central Total | | 2,631 | 1,446 | 1,250 | 2,672 | 1,480 | 5,817 |
| Eastern | hook n line | 211 | 2,762 | 116 | 254 | 110 | 122 |
| | pot | 0 | | 0 | | 0 | 0 |
| | trawl | 66 | 67 | 10 | 14 | 10 | 3 |
| Eastern Total | | 277 | 2,830 | 126 | 267 | 120 | 125 |
| Western | hook n line | 104 | 48 | 521 | 166 | 143 | 365 |
| | pot | 0 | 0 | 0 | 0 | 0 | 0 |
| | trawl | 108 | 152 | 104 | 133 | 86 | 176 |
| Western Total | | 212 | 200 | 625 | 299 | 229 | 541 |
| Grand Total | | 3,120 | 4,476 | 2,000 | 3,238 | 1,828 | 6,484 |

**Table 4. Estimated annual skate catch (all species) in tons by target fishery and gear, 1997-2002**

| Target fishery | gear | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|
| Arrowtooth | trawl | 133 | 21 | 49 | 182 | 48 | 174 |
| Deepflats | trawl | 42 | 31 | 17 | 5 | 7 | 14 |
| Flatheadsole | trawl | 139 | 130 | | 2 | 26 | 102 |
| Other | hook n line | | | 0 | 0 | 0 | 7 |
| | trawl | 446 | 138 | | 14 | 63 | 0 |
| Other Total | | 446 | 138 | 0 | 14 | 63 | 7 |
| Pacific cod | hook n line | 478 | 461 | 789 | 1,823 | 617 | 5,005 |
| | pot | 1 | 0 | 0 | 0 | 0 | 0 |
| | trawl | 476 | 411 | 385 | 219 | 272 | 120 |
| Pacific cod Total | | 954 | 873 | 1,174 | 2,042 | 889 | 5,125 |
| Pollock | trawl | 31 | 52 | 24 | 87 | 53 | 10 |
| Rexsole | trawl | 489 | 172 | 331 | 142 | 107 | 230 |
| Rockfish | hook n line | 223 | | 22 | 75 | 75 | 4 |
| | trawl | 70 | 39 | 71 | 77 | 126 | 113 |
| Rockfish Total | | 293 | 39 | 92 | 151 | 201 | 117 |
| Sablefish | hook n line | 166 | 2,834 | 243 | 336 | 262 | 305 |
| | trawl | | | | 0 | 1 | 0 |
| Sablefish Total | | 166 | 2,834 | 243 | 336 | 263 | 305 |
| Shallowflats | trawl | 427 | 186 | 70 | 275 | 171 | 400 |
| Grand Total | | 3,120 | 4,476 | 2,000 | 3,238 | 1,828 | 6,484 |

**Table 5. Estimated number of skates (all spp.) caught in directed fisheries for Pacific halibut, from IPHC; skates per hook observed on longline surveys expanded to commercial halibut hooks fished**

| IPHC area | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| Area 2C | 21,808 | 19,595 | 21,213 | 25,602 | 26,032 | 18,058 |
| Area 3A | 55,850 | 43,651 | 49,991 | 51,699 | 56,937 | 61,403 |
| Area 3B | 14,329 | 11,943 | 20,040 | 25,775 | 23,035 | 22,651 |
| Area 4A | 13,381 | 7,843 | 10,033 | 16,372 | 18,944 | 24,064 |
| Area 4B | | | | | | 45,265 |
| Area 4CDE | | | | | | 36,378 |

Rescaling IPHC areas to reflect NPFMC management areas
(assuming numbers in EGOA= 2C + 3A/2, CGOA= 3A/2 + 3B/2, and WGOA = 3B/2 + 4A/2)

| NPFMC area | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| EGOA | 49,733 | 41,421 | 46,209 | 51,452 | 54,500 | 48,760 |
| CGOA | 35,089 | 27,797 | 35,016 | 38,737 | 39,986 | 42,027 |
| WGOA | 13,855 | 9,893 | 15,037 | 21,074 | 20,990 | 23,357 |

average wt 13.7448 (assumes species composition of 50% longnose, 20% big, 30% *Bathyraja* with average weights of 13.42 kg, 25.43 kg, and 6.495 kg, respectively, see text)

**Estimated weight in tons of all skates caught in directed fisheries for Pacific halibut**

| NPFMC area | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|
| EGOA | 684 | 569 | 635 | 707 | 749 | 670 |
| CGOA | 482 | 382 | 481 | 532 | 550 | 578 |
| WGOA | 190 | 136 | 207 | 290 | 288 | 321 |
| GOA total | 1,356 | 1,087 | 1,323 | 1,529 | 1,587 | 1,569 |

**Table 6. Skate harvest in metric tons from the GOA, excluding inside Southeast,1988- 2003.**

| | NMFS Area | | | | | |
|---|---|---|---|---|---|---|
| Year | 650 | 649 | 640 | 630 | 620 | 610 |
| 1988 | Confidential | 5 | 0 | 1 | Confidential | 0 |
| 1989 | 0 | Confidential | 0 | 0 | 0 | 0 |
| 1990 | Confidential | 0 | 0 | 1 | 16 | 2 |
| 1991 | 2 | 0 | 4 | 17 | 2 | 28 |
| 1992 | <1 | 0 | 2 | 6 | 5 | 9 |
| 1993 | Confidential | Confidential | 0 | 1 | 0 | 0 |
| 1994 | 1 | 0 | 5 | 32 | 4 | <1 |
| 1995 | 1 | 1 | 5 | 235 | 65 | <1 |
| 1996 | 6 | 6 | 10 | 631 | 256 | Confidential |
| 1997 | 7 | 16 | 18 | 1,022 | 208 | 0 |
| 1998 | 0 | 20 | 4 | 236 | 52 | Confidential |
| 1999 | <1 | 0 | 10 | 88 | 2 | <1 |
| 2000 | Confidential | 0 | 2 | 492 | 63 | 5 |
| 2001 | Confidential | 0 | <1 | 345 | 26 | 2 |
| 2002 | Confidential | Confidential | Confidential | 428 | 107 | 82 |
| 2003 | Confidential | <1 | 51 | 2,285 | 850 | 140 |

Note: does not include at-sea or dockside discards

Source: Alaska Department of Fish and Game fish ticket database, 11/3/03

**Table 7. Skate discard information in metric tons from the Gulf of Alaska, excluding inside Southeastern,1988-2003.**

| | NMFS Area | | | | | |
|---|---|---|---|---|---|---|
| Year | 650 | 649 | 640 | 630 | 620 | 610 |
| 1988 | 1 | 0 | 1 | 2 | 24 | 0 |
| 1989 | 1 | 0 | 6 | 6 | 16 | 2 |
| 1990 | 0 | 0 | 1 | 28 | 97 | 8 |
| 1991 | 0 | 5 | 4 | 195 | 12 | 114 |
| 1992 | 0 | 7 | 5 | 235 | 26 | 42 |
| 1993 | Confidential | Confidential | 7 | 218 | 53 | 7 |
| 1994 | Confidential | 1 | 10 | 205 | 30 | 16 |
| 1995 | 6 | 4 | 42 | 337 | 146 | 5 |
| 1996 | Confidential | 2 | 24 | 325 | 227 | 47 |
| 1997 | 45 | 0 | 14 | 397 | 213 | 30 |
| 1998 | 0 | 0 | 30 | 357 | 92 | 25 |
| 1999 | 0 | 0 | 14 | 206 | 132 | 43 |
| 2000 | 0 | 0 | 5 | 285 | 80 | 123 |
| 2001 | 0 | 2 | 3 | 379 | 40 | 24 |
| 2002 | 0 | 3 | 7 | 125 | 63 | 16 |
| 2003 | 0 | 3 | 5 | 140 | 58 | 27 |

Note: includes at-sea and dockside discards
Source: Alaska Department of Fish and Game fish ticket database, 11/3/03

**Table 8. Skate harvest in metric tons from the state and federal waters of the Gulf of Alaska, excluding inside Southeastern, 1988-2003.**

| | NMFS Area -state waters (0-3 nautical miles) | | | | | | NMFS Area -Federal waters (3-200 nautical miles) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 650 | 649 | 640 | 630 | 620 | 610 | 650 | 649 | 640 | 630 | 620 | 610 |
| 1988 | 0 | 5 | 0 | Conf. | 0 | 0 | Conf. | 0 | 0 | Conf. | Conf. | 0 |
| 1989 | 0 | Conf. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 0 | 0 | 0 | 0 | 0 | 0 | Conf. | 0 | 0 | 1 | 16 | 2 |
| 1991 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 4 | 15 | 2 | 28 |
| 1992 | 0 | 0 | 0 | 3 | 0 | 0 | <1 | 0 | 2 | 3 | 5 | 9 |
| 1993 | 0 | Conf. | 0 | 1 | 0 | 0 | Conf. | 0 | 0 | 0 | 0 | 0 |
| 1994 | 0 | 0 | 0 | 3 | Conf. | 0 | <1 | 0 | 5 | 29 | Conf. | <1 |
| 1995 | <1 | 1 | 0 | 50 | 12 | 0 | <1 | 0 | 5 | 184 | 53 | <1 |
| 1996 | 5 | 6 | 0 | 64 | 125 | Conf. | <1 | 0 | 10 | 567 | 131 | 0 |
| 1997 | 3 | 16 | 0 | 129 | 146 | 0 | 3 | 0 | 18 | 893 | 62 | 0 |
| 1998 | 0 | 20 | 0 | 32 | 17 | Conf. | 0 | 0 | 4 | 204 | 34 | 0 |
| 1999 | 0 | Conf. | 0 | 4 | 0 | 0 | 0 | 0 | 10 | 85 | 2 | <1 |
| 2000 | 0 | 0 | 0 | 10 | 7 | 0 | Conf. | 0 | 2 | 482 | 56 | 5 |
| 2001 | Conf. | 0 | 0 | 34 | 10 | 0 | 0 | 0 | <1 | 312 | 16 | 2 |
| 2002 | 0 | Conf. | 0 | 12 | 8 | 0 | Conf. | 0 | Conf. | 417 | 100 | 82 |
| 2003 | 0 | <1 | 0 | 465 | 67 | 4 | Conf. | 0 | 51 | 1820 | 783 | 136 |

Note: does not include at-sea or dockside discards
Source: Alaska Department of Fish and Game fish ticket database, 11/3/03

**Table 9. Skate harvest in metric tons by gear type from of the Gulf of Alaska, excluding inside Southeastern, 2003.**

| | Longline | | | | | | Trawl | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 650 | 649 | 640 | 630 | 620 | 610 | 650 | 649 | 640 | 630 | 620 | 610 |
| 1988 | Conf. | 5 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | Conf | 0 |
| 1989 | 0 | Conf. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | Conf. | 0 | 0 | 0 | 0 | 0 | Conf. | 0 | 0 | 1 | 16 | 2 |
| 1991 | 0 | 0 | Conf. | 2 | 0 | 0 | 2 | 0 | 4 | 15 | 2 | 28 |
| 1992 | Conf. | 0 | 0 | 6 | 0 | 1 | Conf. | 0 | 2 | <1 | 5 | 8 |
| 1993 | Conf. | Conf. | 0 | 1 | 0 | 0 | 0 | Conf. | 0 | 0 | 0 | <1 |
| 1994 | <1 | 0 | 0 | Conf. | Conf. | 0 | 0 | 0 | 5 | 31 | 3 | <1 |
| 1995 | <1 | 1 | Conf. | 104 | 4 | 0 | 0 | 0 | 5 | 130 | 61 | <1 |
| 1996 | 6 | 5 | 2 | 79 | 9 | 0 | 0 | 1 | 8 | 549 | 247 | Conf |
| 1997 | 7 | 16 | 1 | 131 | 8 | 0 | 0 | 0 | 17 | 890 | 200 | 0 |
| 1998 | 0 | 19 | Conf. | 37 | 0 | 0 | 0 | <1 | Conf. | 197 | 52 | Conf |
| 1999 | <1 | Conf. | 0 | 14 | <1 | 0 | 0 | 0 | 10 | 74 | 2 | <1 |
| 2000 | Conf. | 0 | 0 | 25 | <1 | 0 | Conf. | 0 | 2 | 466 | 62 | 5 |
| 2001 | Conf. | 0 | <1 | 70 | 17 | 2 | 0 | 0 | 0 | 276 | 9 | 0 |
| 2002 | Conf. | Conf. | Conf. | 33 | 4 | 75 | 0 | Conf. | 0 | 395 | 103 | 8 |
| 2003 | Conf. | 0 | 51 | 1438 | 191 | 120 | 0 | <1 | 0 | 847 | 659 | 20 |

Note: does not include at-sea or dockside discards

**Table 10. Spatially estimated incidental skate catch (t) in groundfish fisheries by species, area and gear (2003 percentages are preliminary and reflect a mixture of spatially estimated and directly observed species compositions. Gulfwide percentages are not available for 2003.)**

| species | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | Avg % | 2003% | Area Gear |
|---|---|---|---|---|---|---|---|---|---|
| big | 66 | 49 | 31 | 288 | 125 | 1,789 | 16.72% | 26.76% | CGOA hook and line |
| longnose | 284 | 248 | 190 | 846 | 316 | 2,251 | 47.73% | 31.57% | CGOA hook and line |
| all others | 202 | 187 | 196 | 681 | 261 | 794 | 35.56% | 41.67% | CGOA hook and line |
| big | 1 | | | | | | 96.82% | | CGOA pot |
| longnose | 0 | | | | | | 1.86% | | CGOA pot |
| all others | 0 | | | | | | 1.32% | | CGOA pot |
| big | 645 | 342 | 224 | 291 | 283 | 230 | 31.21% | 23.26% | CGOA trawl |
| longnose | 866 | 403 | 365 | 375 | 356 | 482 | 44.33% | 56.42% | CGOA trawl |
| all others | 567 | 216 | 245 | 191 | 138 | 271 | 24.46% | 20.32% | CGOA trawl |
| big | 41 | 228 | 12 | 8 | 11 | 20 | 11.20% | 42.66% | EGOA hook n line |
| longnose | 117 | 1,670 | 59 | 143 | 60 | 52 | 53.18% | 34.61% | EGOA hook n line |
| all others | 53 | 864 | 46 | 103 | 40 | 51 | 35.62% | 22.73% | EGOA hook n line |
| big | 7 | 6 | 1 | 2 | 0 | 1 | 9.95% | 17.66% | EGOA trawl |
| longnose | 48 | 48 | 7 | 10 | 7 | 2 | 70.25% | 65.53% | EGOA trawl |
| all others | 12 | 13 | 2 | 2 | 3 | 1 | 19.79% | 16.82% | EGOA trawl |
| big | 54 | 20 | 240 | 82 | 78 | 192 | 49.57% | 27.63% | WGOA hook n line |
| longnose | 5 | 1 | 19 | 8 | 11 | 24 | 5.05% | 29.25% | WGOA hook n line |
| all others | 45 | 26 | 263 | 76 | 54 | 148 | 45.38% | 43.12% | WGOA hook n line |
| big | 46 | 65 | 31 | 18 | 25 | 44 | 30.41% | 12.67% | WGOA trawl |
| longnose | 14 | 15 | 8 | 15 | 7 | 14 | 9.55% | 17.85% | WGOA trawl |
| all others | 48 | 73 | 64 | 100 | 55 | 119 | 60.05% | 69.48% | WGOA trawl |
| big | 860 | 710 | 539 | 689 | 522 | 2,275 | 26.46% | | Gulfwide |
| longnose | 1,333 | 2,386 | 646 | 1,397 | 757 | 2,825 | 44.19% | | Gulfwide |
| bathy | 927 | 1,380 | 815 | 1,152 | 550 | 1,383 | 29.35% | | Gulfwide |

**Table 11(a) Estimates of incidental landings vs target skate landings in metric tons (derived from Tables 6-7)**

| Retained | EGOA | CGOA | WGOA | |
|---|---|---|---|---|
| average 97-02 | 7 | 441 | 22 | |
| 2003 | 51 | 3,135 | 140 | |
| Discards | | | | |
| average 97-02 | 19 | 395 | 44 | |
| 2003 | 5 | 199 | 27 | |
| Retained plus discarded skates | | | | |
| average 97-02 | 26 | 836 | 66 | |
| total 2003 | 56 | 3,333 | 167 | |
| Estimated targeted skate catch (total 2003 - average 97-02) | | | | |
| target 2003 | 30 | 2,498 | 101 | **Sum: 2,629** |

Table 11(b) Estimates of incidental landings vs target skate landings by fish ticket target and MRA class

| **Total Skate catch 2003** | **Total Pounds** | **Total mt** | **No. of fish tickets** |
|---|---|---|---|
| *Total harvest* | *7,335,049* | *3,327* | *828* |
| Longline | 3,969,223 | 1,800 | 415 |
| Trawl (non-pelagic, pelagic) | 3,363,626 | 1,526 | 411 |
| Other (jig, pot) | Confidential | Confidential | 2 |
| | **Groundfish tickets (cod target)** | | |
| ****Skate target fishery**** | **> MRA 20% (lbs.)** | **> MRA 20% (mt)** | **Tickets > MRA 20%** |
| *Total harvest* | *6,046,552* | ***2,743*** | *344* |
| Longline | 3,124,638 | 1,417 | 187 |
| Trawl (non-pelagic, pelagic) | 2,921,914 | 1,325 | 157 |
| Other (jig, pot) | 0 | 0 | 0 |
| | **Groundfish Tickets (cod target)** | | |
| ****Incidental skate catch**** | **< MRA 20% (lbs.)** | **< MRA 20% (mt)** | **Tickets < MRA 20%** |
| *Total harvest* | *490,918* | *223* | *308* |
| Longline | 210,536 | 95 | 220 |
| Trawl (non-pelagic, pelagic) | 279,103 | 127 | 87 |
| Other (jig, pot) | Confidential | Confidential | 1 |
| ****Incidental skate catch**** | **Halibut tickets (lbs.)** | **Halibut tickets (mt)** | |
| *Total harvest* | *124,132* | *107* | |
| Longline | 124,132 | 107 | |
| Trawl (non-pelagic, pelagic) | 0 | 0 | |
| Other (jig, pot) | 0 | 0 | |
| ****Incidental skate catch**** | **Tickets not categorized** | **Tix not categorized (mt)** | **No. tix not categorized** |
| *Total harvest* | *673,449* | *305* | *69* |
| Longline | 231,176 | 105 | 34 |
| Trawl (non-pelagic, pelagic) | 441,351 | 200 | 34 |
| Other (jig, pot) | Confidential | Confidential | 1 |

Table 12. Percentage of each skate species by sex in sampled Kodiak skate landings, summer, 2003

| percentages | | H&L | NPT | total |
|---|---|---|---|---|
| *B. aleutica* | F | 0.00% | 0.04% | 0.01% |
| *B. aleutica* Total | | 0.00% | 0.04% | 0.01% |
| *B. interrupta* | F | 0.18% | 1.30% | 0.57% |
| | M | 0.00% | 0.13% | 0.04% |
| *B. interrupta* Total | | 0.18% | 1.42% | 0.61% |
| *B. parmifera* | F | 0.00% | 0.50% | 0.17% |
| *B. parmifera* Total | | 0.00% | 0.50% | 0.17% |
| *R. binoculata* | F | 76.83% | 82.74% | 78.90% |
| | M | 18.59% | 9.47% | 15.39% |
| *R. binoculata* Total | | 95.42% | 92.20% | 94.29% |
| *R. rhina* | F | 2.33% | 2.05% | 2.23% |
| | M | 2.07% | 3.79% | 2.67% |
| *R. rhina* Total | | 4.40% | 5.84% | 4.90% |

**Table 13. GOA trawl survey biomass estimates for major skate species, 1984-2003**

| Area | YEAR | big skate | longnose skate | Aleutian skate | Bering skate | Alaska skate | skate unident. |
|---|---|---|---|---|---|---|---|
| EASTERN GOA (640-650) | 1984 | 6,566 | 6,722 | 0 | 187 | 4 | 96 |
| | 1987 | 2,925 | 3,923 | 25 | 68 | 0 | 173 |
| | 1990 | 11,501 | 2,242 | 216 | 159 | 107 | 136 |
| | 1993 | 15,836 | 3,539 | 0 | 119 | 0 | 1,340 |
| | 1996 | 3,391 | 5,620 | 796 | 673 | 0 | 3 |
| | 1999 | 9,606 | 7,714 | 1,310 | 229 | 76 | 85 |
| | 2003 | 11,981 | 13,081 | 640 | 136 | 63 | 52 |
| WESTERN GOA (610) | 1984 | 3,339 | 0 | 358 | 45 | 0 | 325 |
| | 1987 | 4,313 | 41 | 112 | 20 | 0 | 351 |
| | 1990 | 1,745 | 1,045 | 139 | 28 | 0 | 0 |
| | 1993 | 2,287 | 105 | 292 | 0 | 0 | 651 |
| | 1996 | 13,130 | 278 | 82 | 52 | 119 | 496 |
| | 1999 | 11,038 | 1,747 | 1,928 | 218 | 220 | 46 |
| | 2001 | 8,425 | 104 | 1,858 | 170 | 1,213 | 0 |
| | 2003 | 9,602 | 782 | 4,401 | 39 | 265 | 0 |
| CENTRAL GOA (620-630) | 1984 | 17,635 | 2,280 | 1,235 | 230 | 0 | 2,154 |
| | 1987 | 20,855 | 2,667 | 601 | 519 | 14 | 1,454 |
| | 1990 | 9,071 | 8,708 | 896 | 1,861 | 771 | 9,609 |
| | 1993 | 21,586 | 14,158 | 60 | 107 | 0 | 3,572 |
| | 1996 | 26,544 | 20,328 | 5,681 | 1,492 | 810 | 1,566 |
| | 1999 | 34,007 | 29,872 | 8,055 | 3,371 | 1,272 | 621 |
| | 2001 | 30,658 | 23,171 | 4,734 | 2,423 | 2,422 | 14 |
| | 2003 | 33,864 | 25,856 | 10,772 | 3,240 | 1,600 | 296 |

Table 14. Options for setting ABC and OFL of skates in the GOA (provided at Plan Team request)

| | **big** | **longnose** | **all *Bathyraja*** |
|---|---|---|---|
| **most recent GOA trawl survey biomass estimate** | | | |
| EGOA | 11,981 | 13,081 | 891 |
| WGOA | 17,635 | 2,280 | 3,619 |
| CGOA | 0 | 0 | 0 |
| | | | |
| **10yr avg (1993-2003) trawl survey biomass estimate** | | | |
| EGOA | 10,203 | 7,488 | 1,380 |
| WGOA | 11,966 | 1,038 | 2,945 |
| CGOA | 32,843 | 26,300 | 12,940 |
| | | | |
| **avg all GOA trawl survey biomass estimates** | | | |
| EGOA | 8,829 | 6,120 | 956 |
| WGOA | 8,522 | 798 | 2,040 |
| CGOA | 25,955 | 20,349 | 10,874 |
| | | | |
| **Most Recent Biomass** | **big** | **longnose** | **all *Bathyraja*** |
| E OFL | 1,198 | 1,308 | 89 |
| W OFL | 1,764 | 228 | 362 |
| C OFL | 0 | 0 | 0 |
| Gulfwide OFL | 2,962 | 1,536 | 451 |
| | | | |
| E ABC | 899 | 981 | 67 |
| W ABC | 1,323 | 171 | 271 |
| C ABC | 0 | 0 | 0 |
| Gulfwide ABC | 2,221 | 1,152 | 338 |
| | | | |
| **10yr avg Biomass** | **big** | **longnose** | **all *Bathyraja*** |
| E OFL | 1,020 | 749 | 138 |
| W OFL | 1,197 | 104 | 295 |
| C OFL | 3,284 | 2,630 | 1,294 |
| Gulfwide OFL | 5,501 | 3,483 | 1,727 |
| | | | |
| E ABC | 765 | 562 | 104 |
| W ABC | 897 | 78 | 221 |
| C ABC | 2,463 | 1,972 | 971 |
| Gulfwide ABC | 4,126 | 2,612 | 1,295 |
| | | | |
| **Avg all Biomass** | **big** | **longnose** | **all *Bathyraja*** |
| E OFL | 883 | 612 | 96 |
| W OFL | 852 | 80 | 204 |
| C OFL | 2,595 | 2,035 | 1,087 |
| Gulfwide OFL | 4,331 | 2,727 | 1,387 |
| | | | |
| E ABC | 662 | 459 | 72 |
| W ABC | 639 | 60 | 153 |
| C ABC | 1,947 | 1,526 | 816 |
| Gulfwide ABC | 3,248 | 2,045 | 1,040 |

Recommended method follows on the next page; the above estimates are provided at the request of the Plan Team.

**Table 14, continued: Recommended method for skate ABC OFL is here last 3 surveys average (spp. identification best)**

| | big | longnose | all *Bathyraja* |
|---|---|---|---|
| EGOA biomass | 10,793 | 10,397 | 1,296 |
| WGOA biomass | 9,688 | 878 | 3,453 |
| CGOA biomass | 32,843 | 26,300 | 12,940 |
| | | | |
| E OFL | 1,079 | 1,040 | |
| W OFL | 969 | 88 | |
| C OFL | 3,284 | 2,630 | |
| Gulfwide OFL | | | 1,769 |
| | | | |
| E ABC | 809 | 780 | |
| W ABC | 727 | 66 | |
| C ABC | 2,463 | 1,972 | |
| Gulfwide ABC | | | 1,327 |

**Table 15. Comparison of proposed management with estimated catch (t) by species, 1997-2002. See text for species catch estimation methods.**

| **Proposed management measures for 2004** | | | **Historical catch estimates** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** |
|---|---|---|---|---|---|---|---|---|---|
| | | | Gulfwide all area all skate species catch | 3,120 | 4,476 | 2,000 | 3,238 | 1,828 | 6,484 |
| species | C ABC | C OFL | Central GOA | | | | | | |
| big | 2,463 | 3,284 | big | 712 | 391 | 255 | 579 | 408 | 2,018 |
| longnose | 1,972 | 2,630 | longnose | 1,149 | 651 | 554 | 1,221 | 672 | 2,734 |
| | E ABC | E OFL | Eastern GOA | | | | | | |
| big | 809 | 1,079 | big | 48 | 234 | 13 | 10 | 11 | 21 |
| longnose | 780 | 1,040 | longnose | 164 | 1,718 | 65 | 153 | 67 | 54 |
| | W ABC | W OFL | Western GOA | | | | | | |
| big | 727 | 969 | big | 100 | 85 | 271 | 100 | 103 | 236 |
| longnose | 66 | 88 | longnose | 19 | 16 | 26 | 23 | 18 | 38 |
| | Gulfwide ABC | Gulfwide OFL | Gulfwide | | | | | | |
| all *Bathy*. | 1,327 | 1,769 | all *Bathyraja* | 927 | 1,380 | 815 | 1,152 | 550 | 1,383 |

Table 16. Comparison of estimated incidental and directed skate catch (t) by species and area with proposed management measures. See text for estimation methods.

| **proposed management measures for 2004** | | | | **Average groundfish incidental catch 97-02** | **Average halibut incidental catch 97-02** | **Sum incidental catch** | **Remaining ABC for directed fishery** | **Remaining OFL for directed fishery** | **Estimated directed fishery 2003** |
|---|---|---|---|---|---|---|---|---|---|
| | | | annual total catch | 3,525 | 1,409 | 4,933 | | | 2,700 |
| species | C ABC | C OFL | Central GOA | | | | | | |
| big | 2,463 | 3,284 | big | 727 | 84 | 811 | 1,652 | 2,473 | 2,400 |
| longnose | 1,972 | 2,630 | longnose | 1,164 | 239 | 1,403 | 570 | 1,227 | 300 |
| | E ABC | E OFL | Eastern GOA | | | | | | |
| big | 809 | 1,079 | big | 56 | 75 | 131 | 679 | 948 | |
| longnose | 780 | 1,040 | longnose | 370 | 356 | 726 | 54 | 314 | |
| | W ABC | W OFL | Western GOA | | | | | | |
| big | 727 | 969 | big | 149 | 118 | 268 | 459 | 701 | |
| longnose | 66 | 88 | longnose | 23 | 12 | 35 | 30 | 52 | |
| | Gulfwide ABC | Gulfwide OFL | Gulfwide | | | | | | |
| all *Bathys* | 1,327 | 1,769 | all *Bathyraja* | 1,035 | 525 | 1,559 | -233 | 210 | |

Figure 1. Big skate, *Raja binoculata*, with stock assessment author for scale.

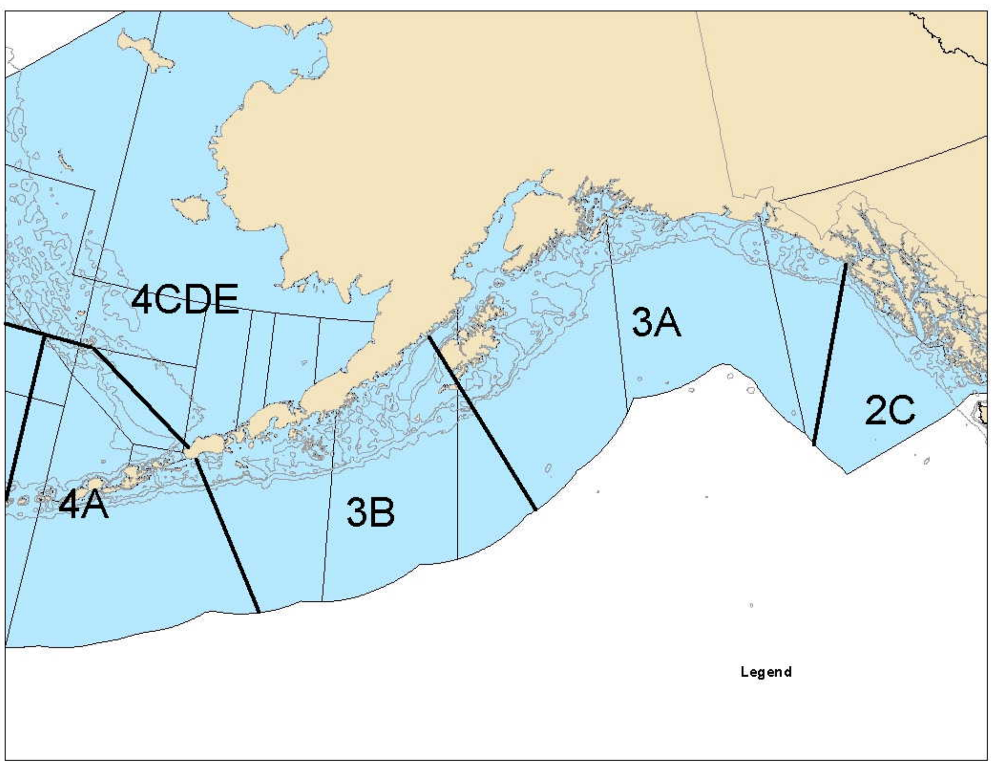



Figure 2. IPHC management areas superimposed on NPFMC management areas in the GOA

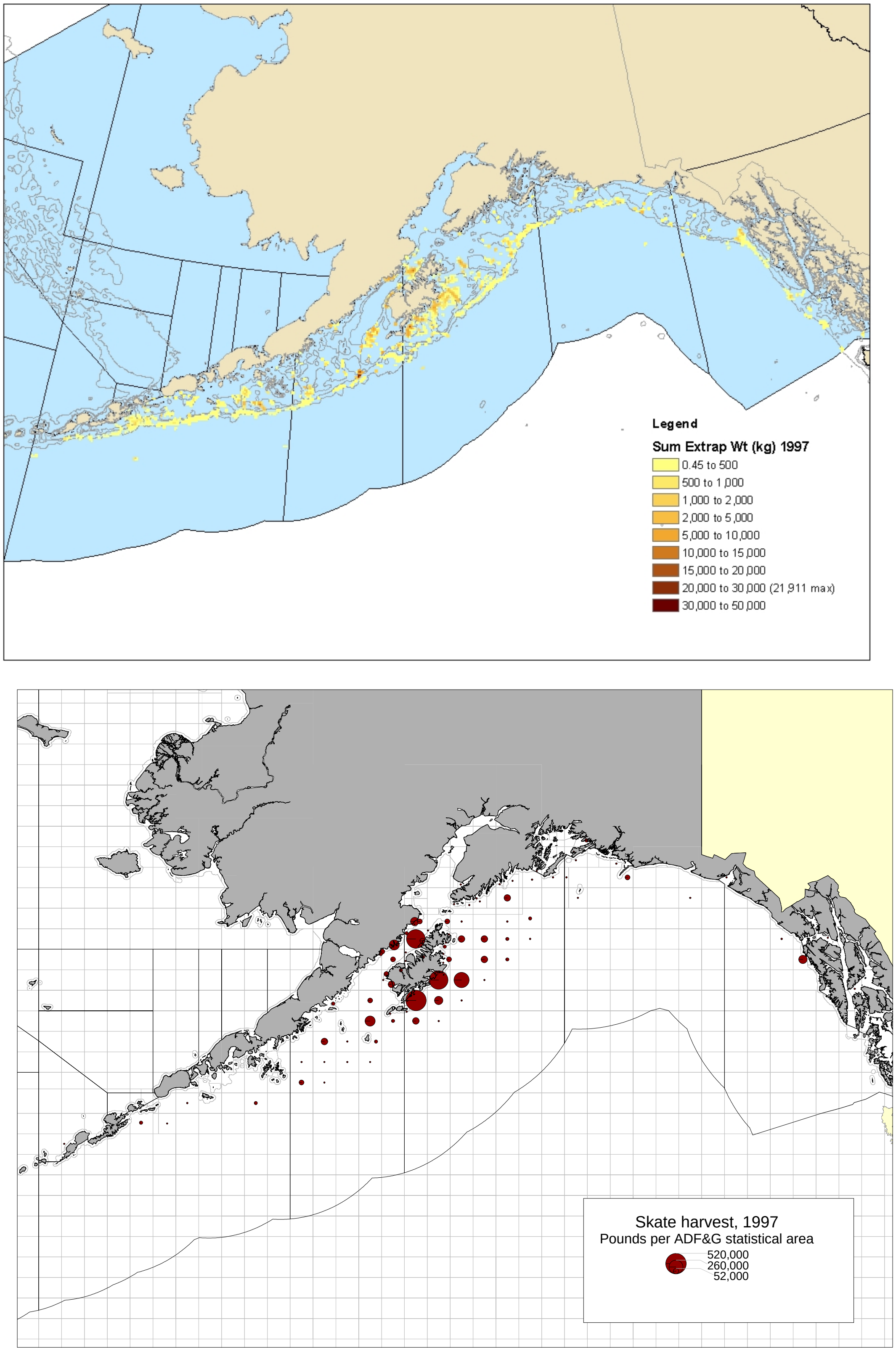
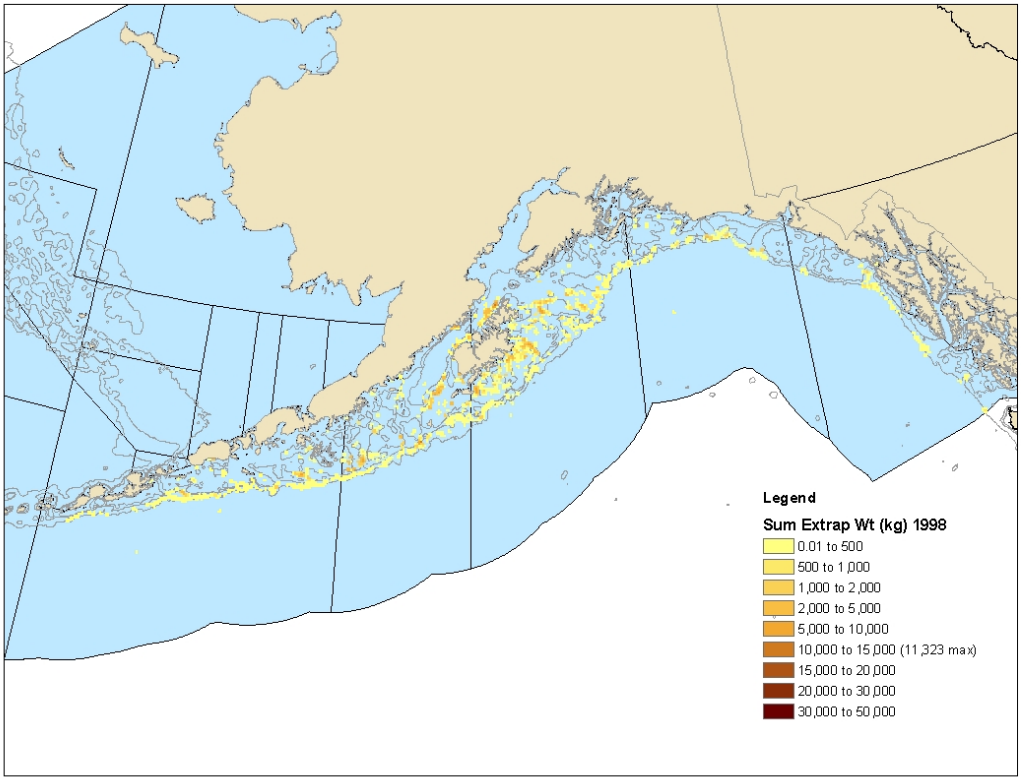



Figure 3. Skate catch from observer data (top) and fish ticket data (bottom), 1997.



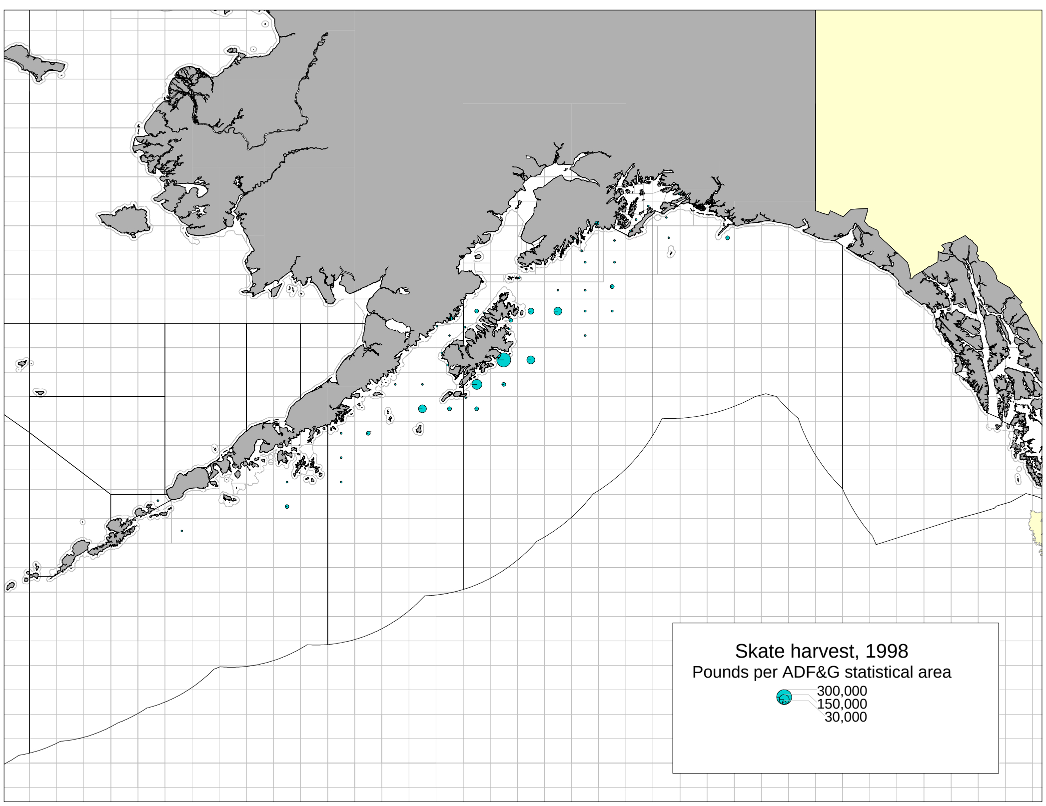
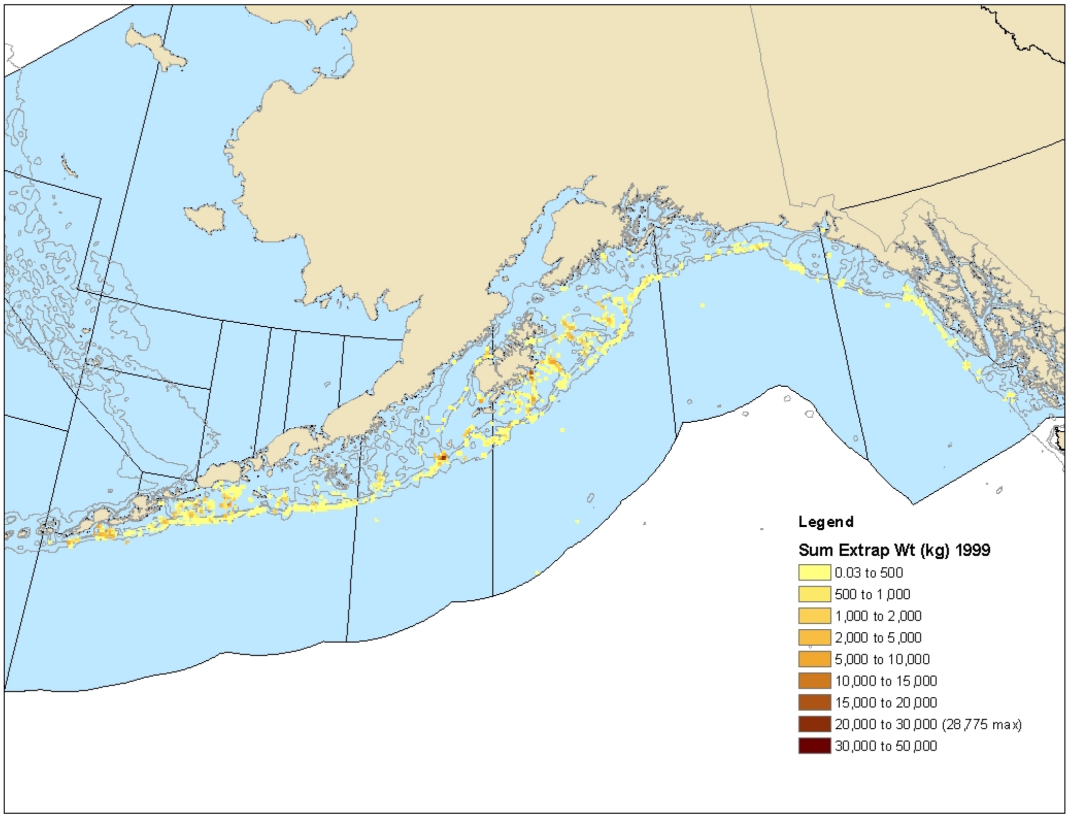




Figure 4. Skate catch from observer data (top) and fish ticket data (bottom), 1998.



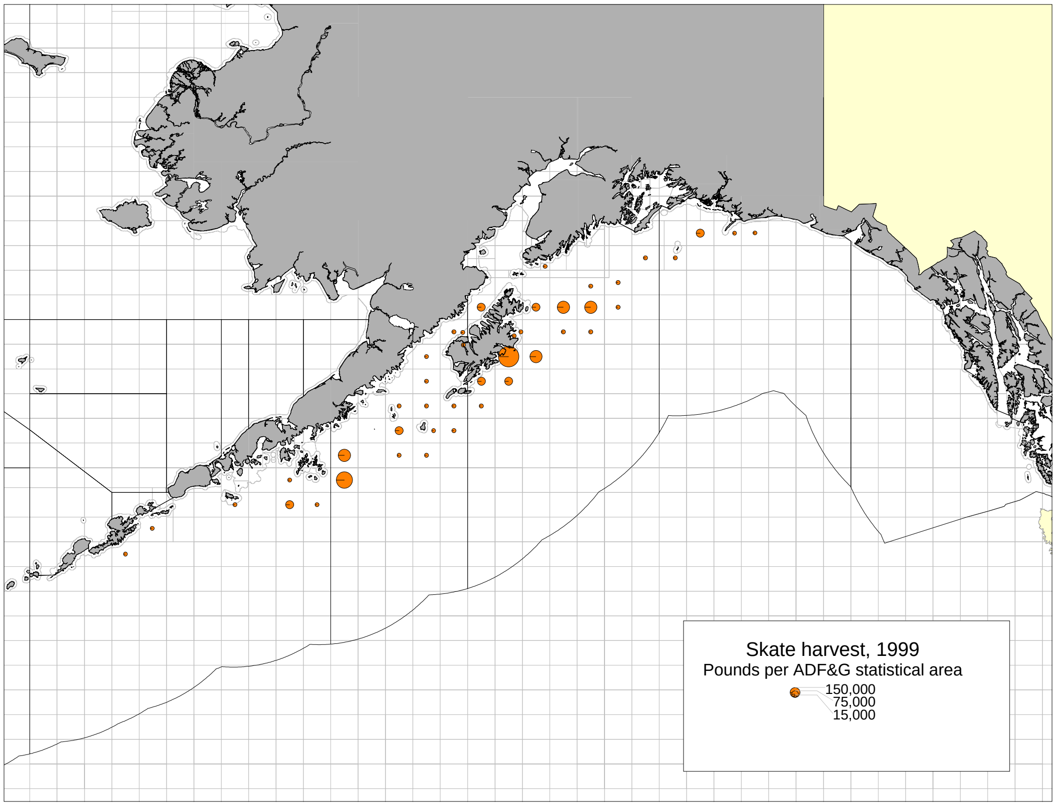
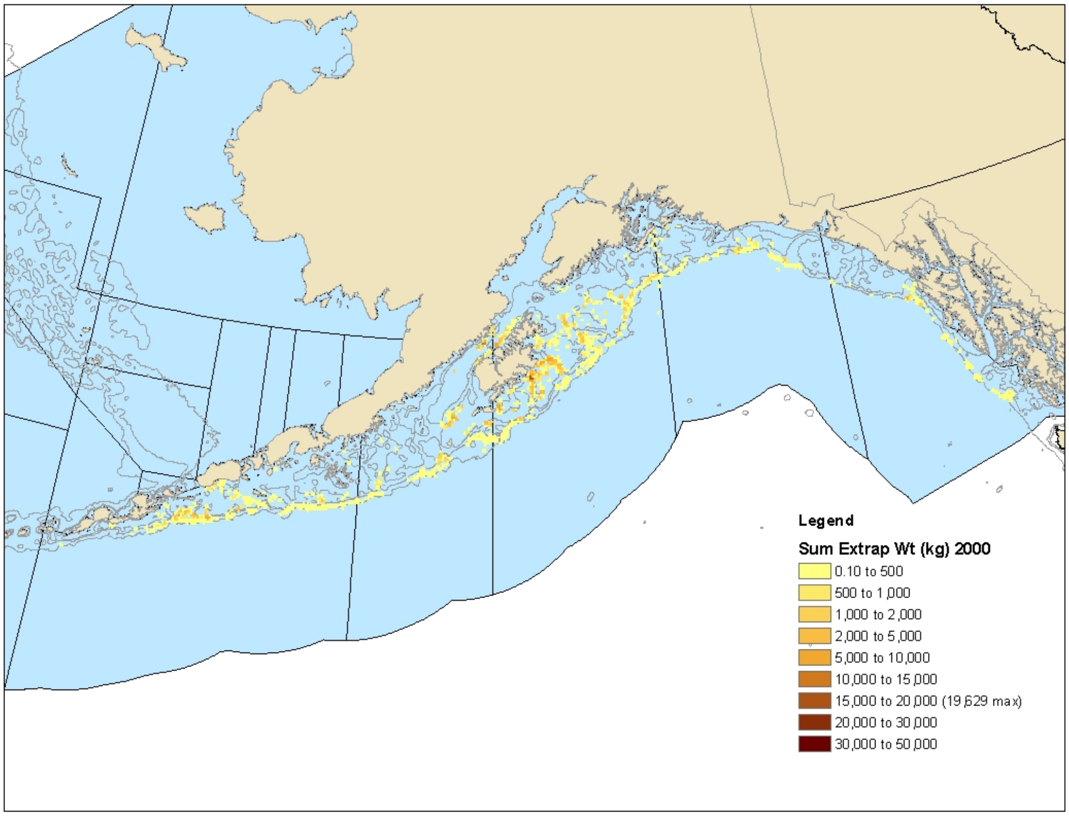




Figure 5. Skate catch from observer data (top) and fish ticket data (bottom), 1999.



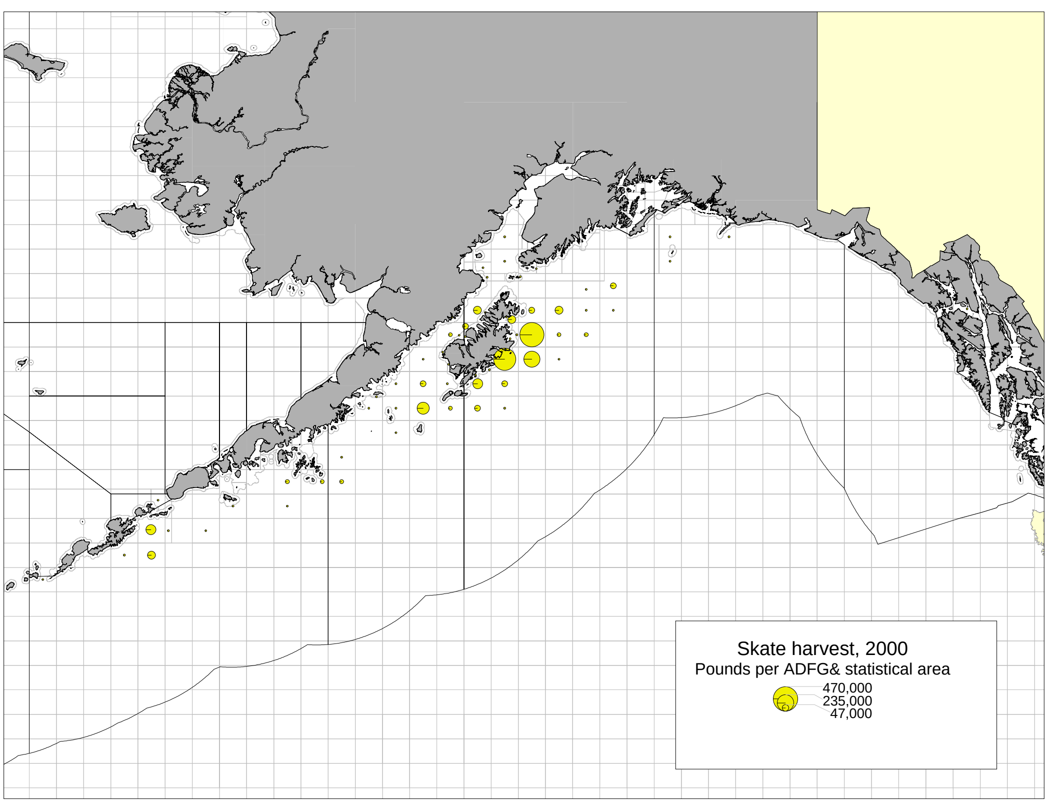




Figure 6. Skate catch from observer data (top) and fish ticket data (bottom), 2000.

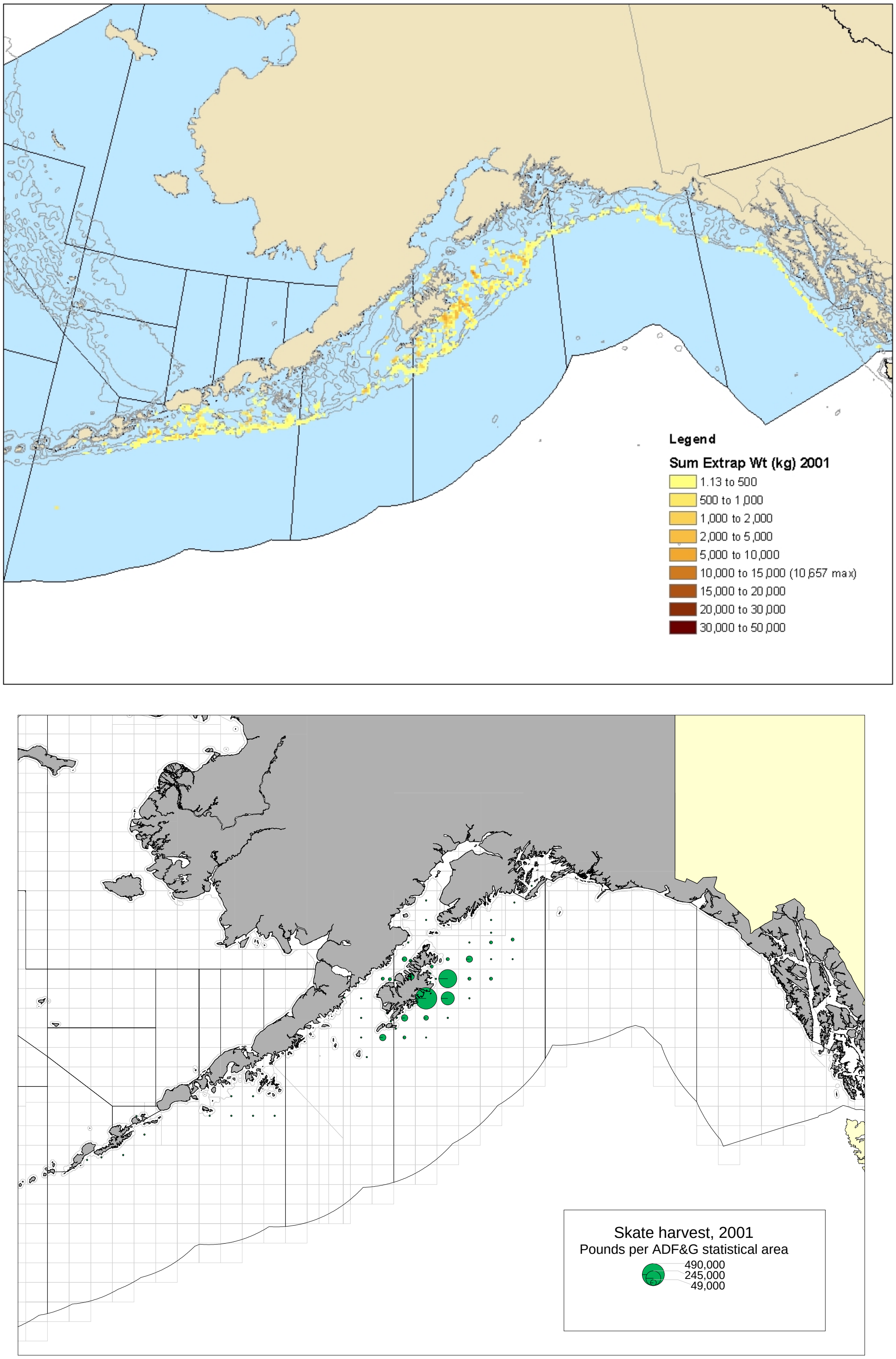
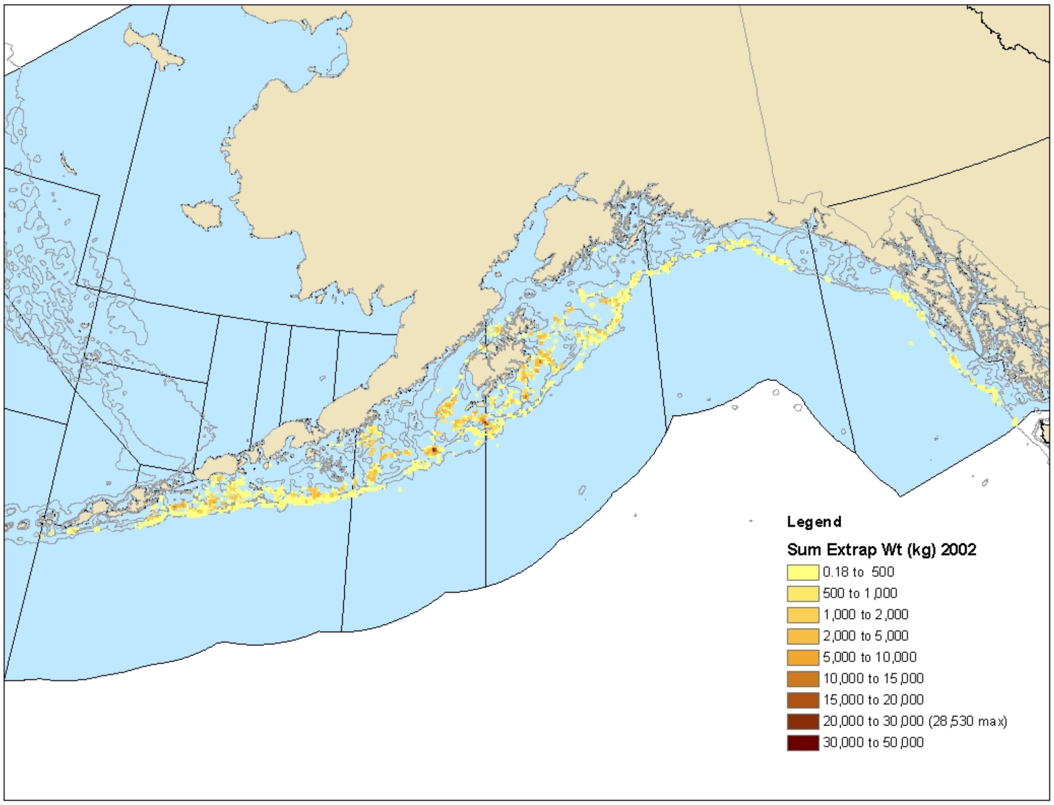



Figure 7. Skate catch from observer data (top) and fish ticket data (bottom), 2001.



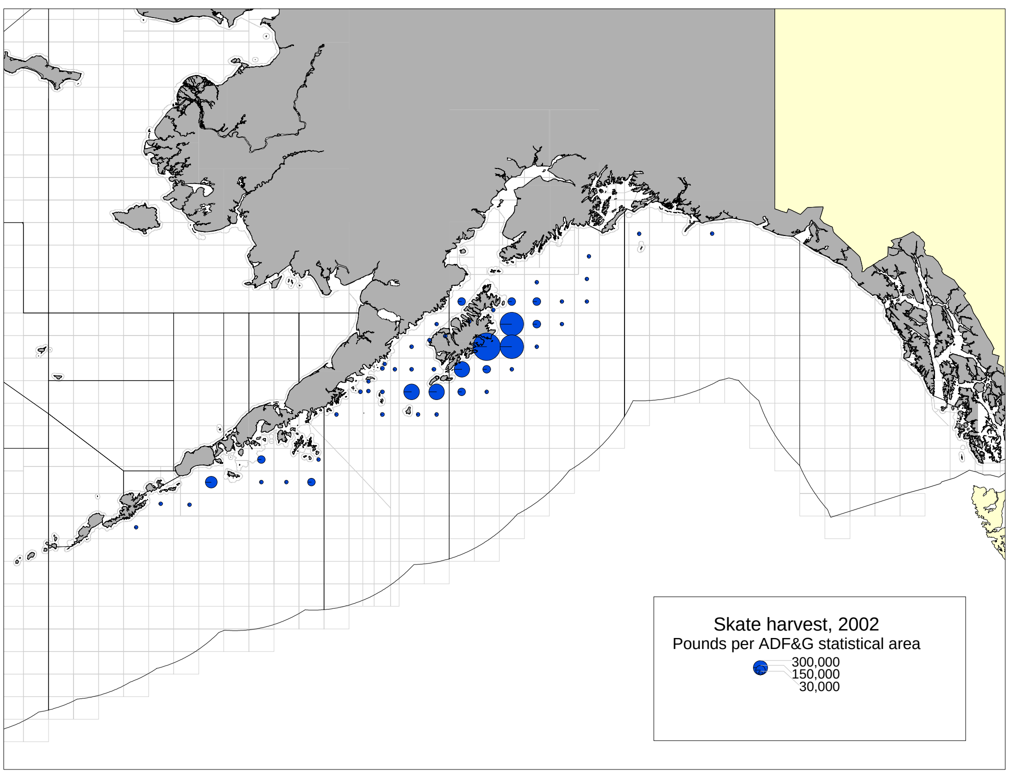
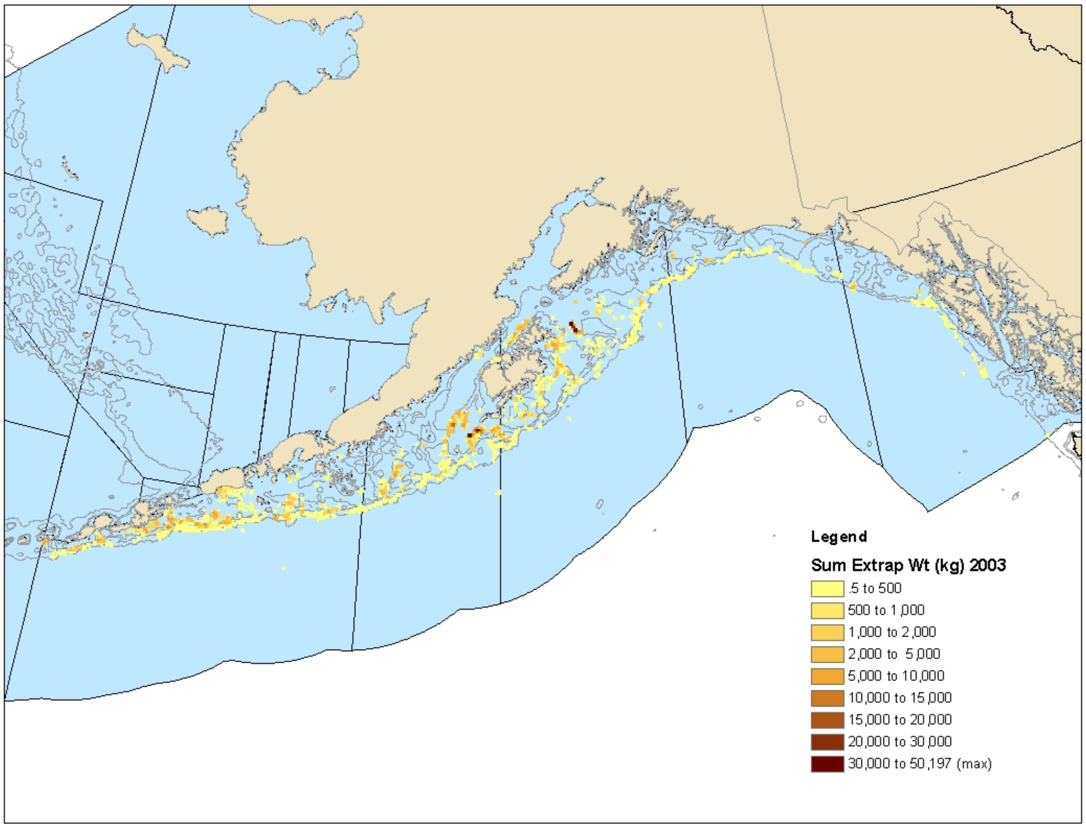




Figure 8. Skate catch from observer data (top) and fish ticket data (bottom), 2002.



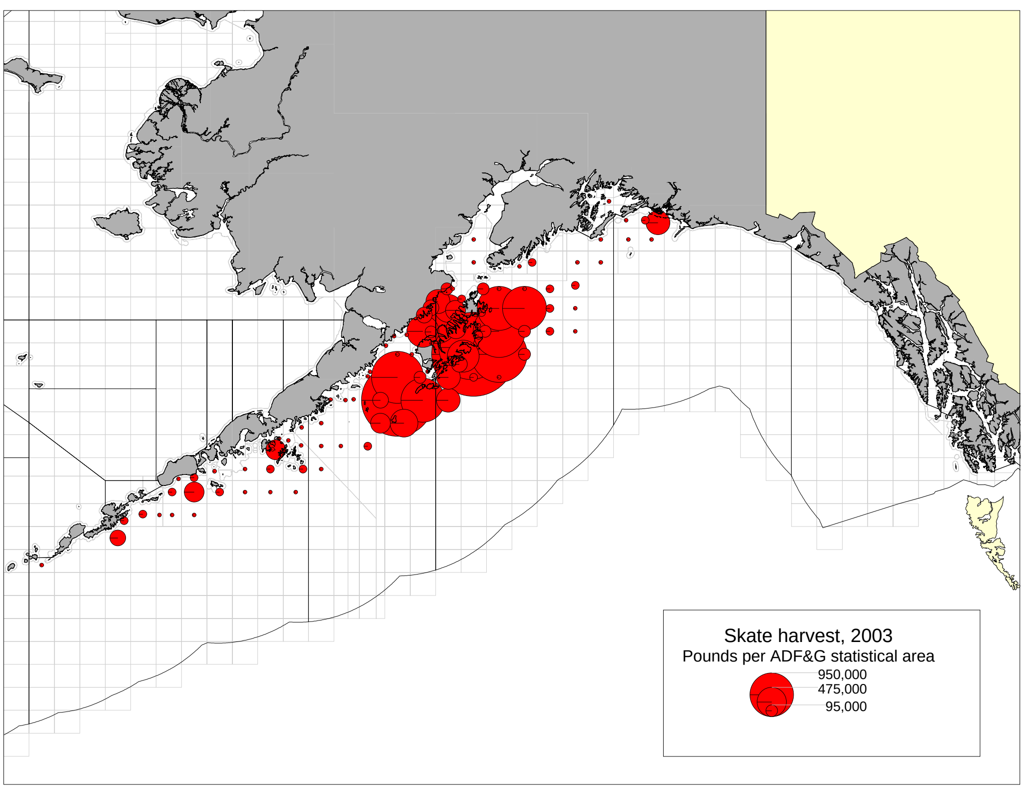




Figure 9. Skate catch from observer data (top) and fish ticket data (bottom), 2003.

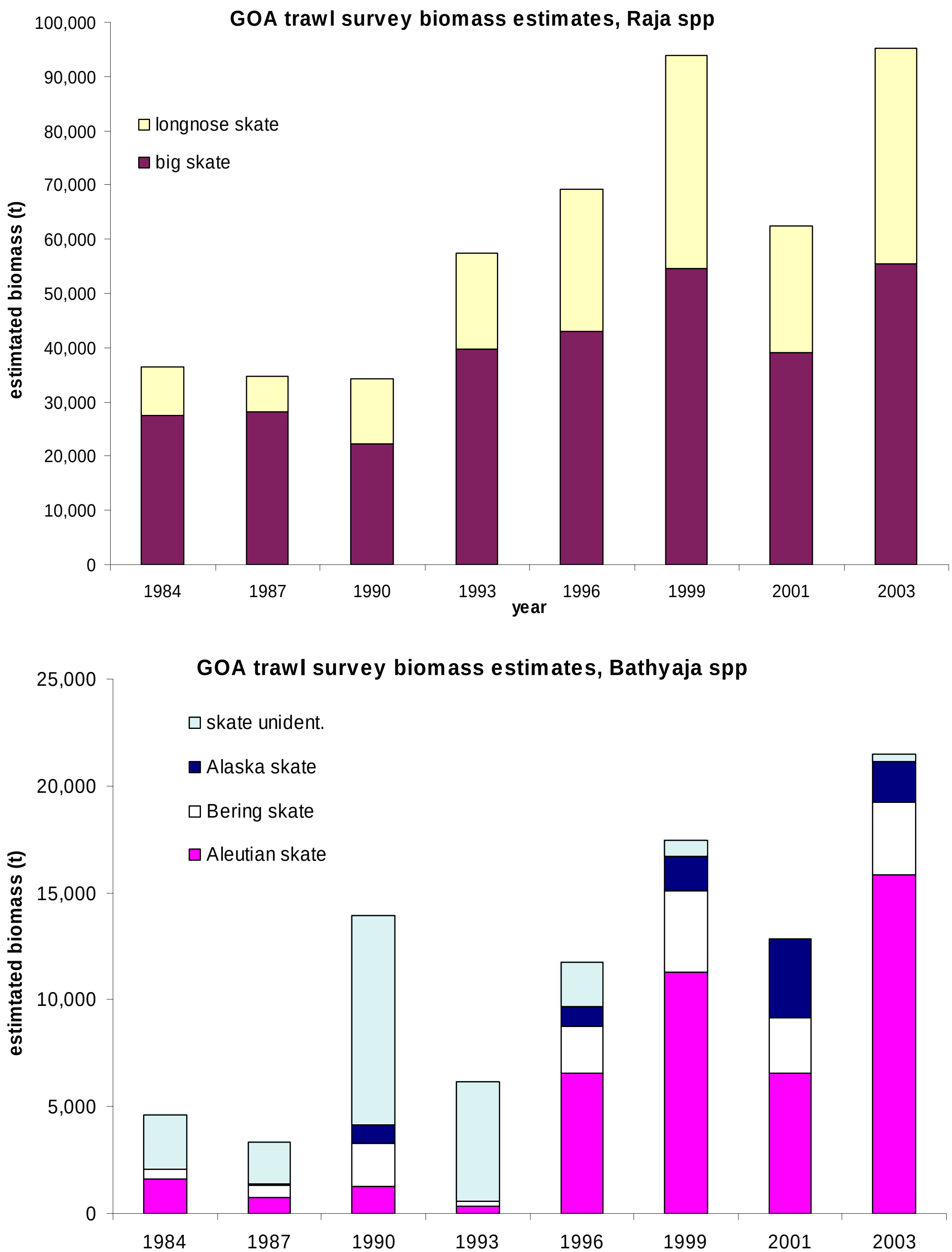



Figure 10. Survey biomass trends for major GOA skate species

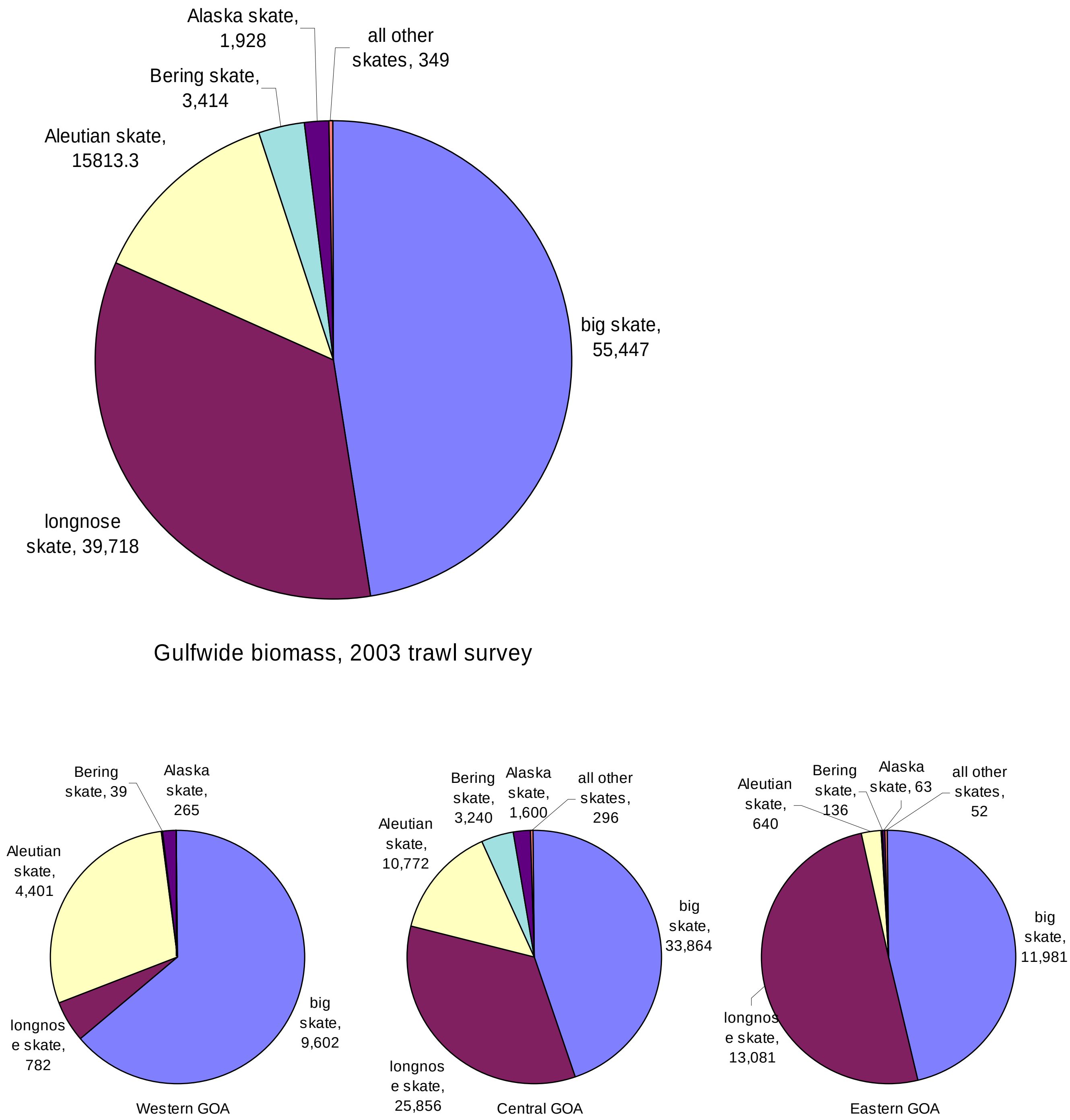
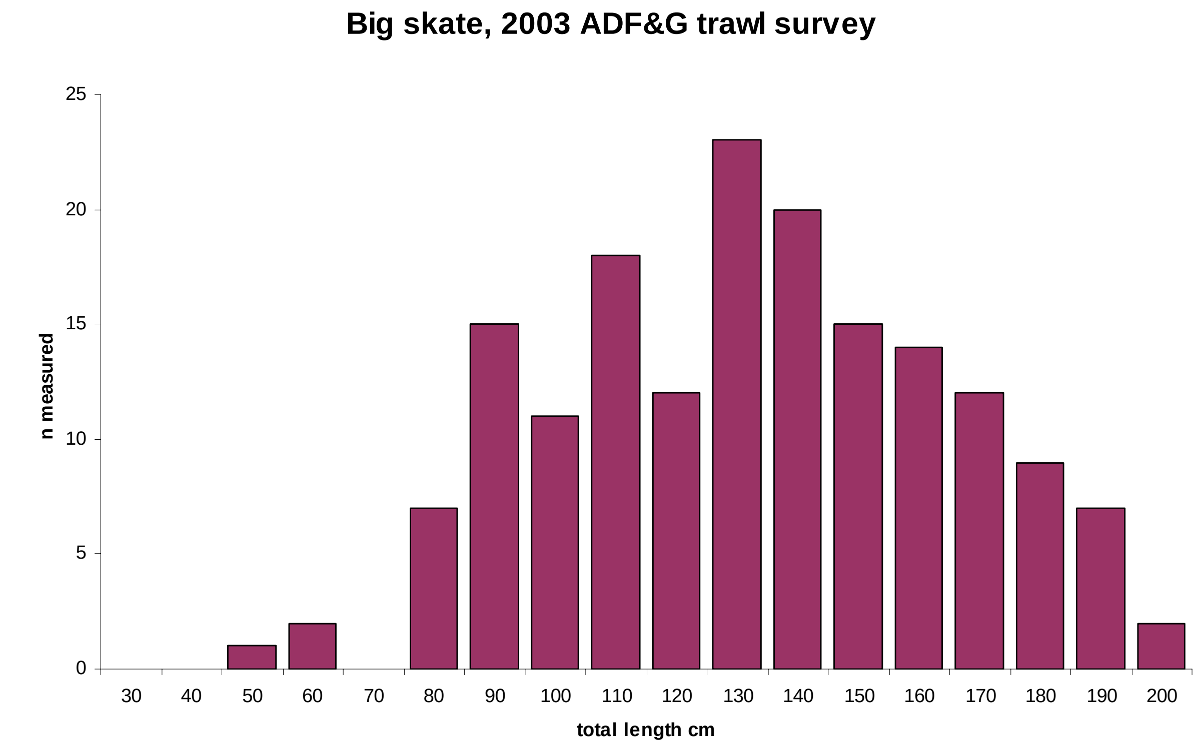



Figure 11. Distribution of skate biomass by species in 2003 gulfwide (top) and between areas (bottom)



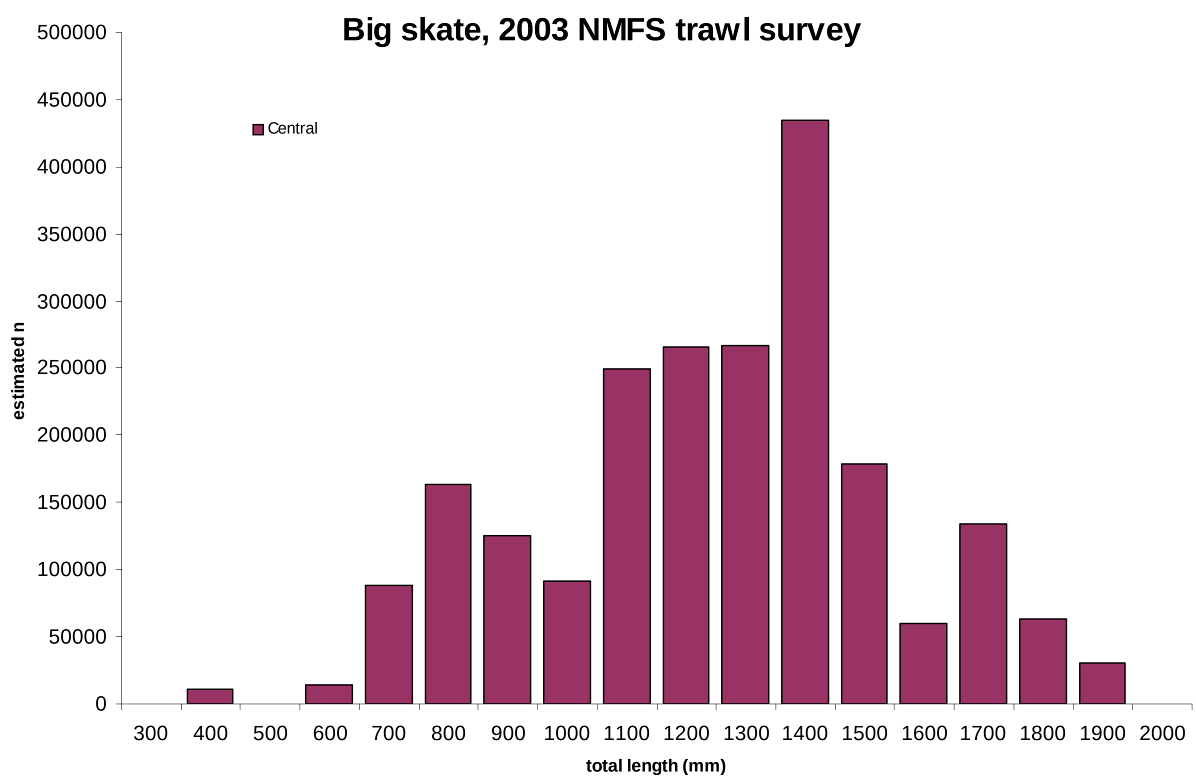




Figure 12. Comparison of ADF&G survey size composition for big skates with NMFS central GOA .

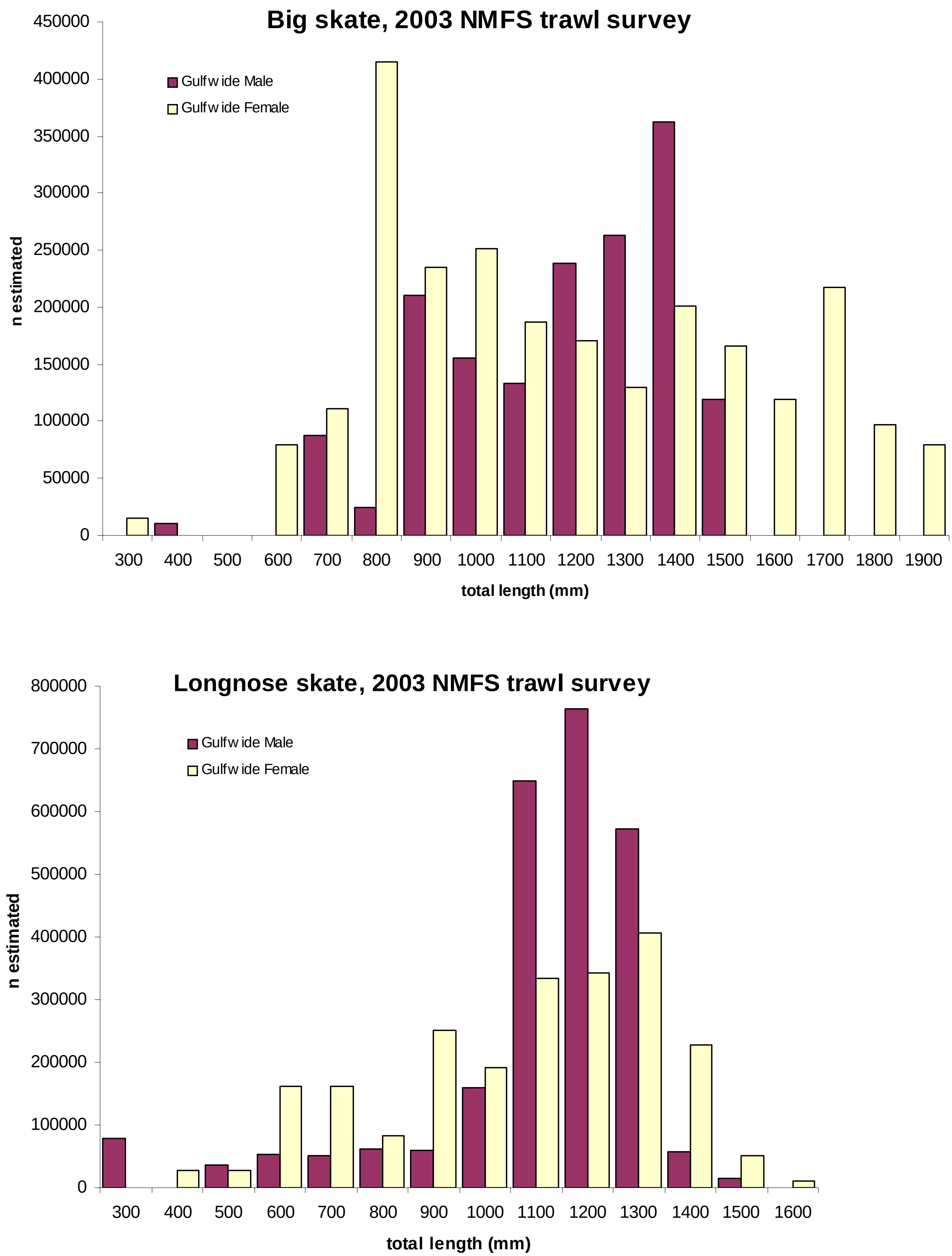
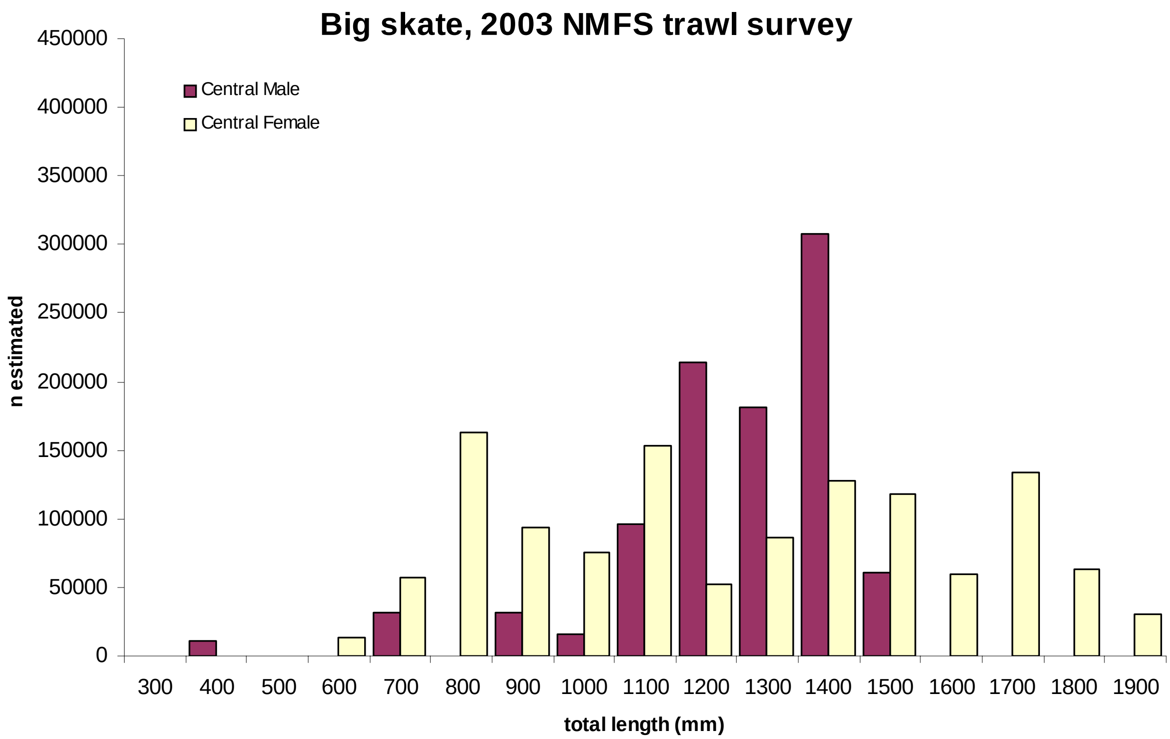



Figure 13. 2003 NMFS trawl survey size composition for big skates (top) and longnose skates (bottom)



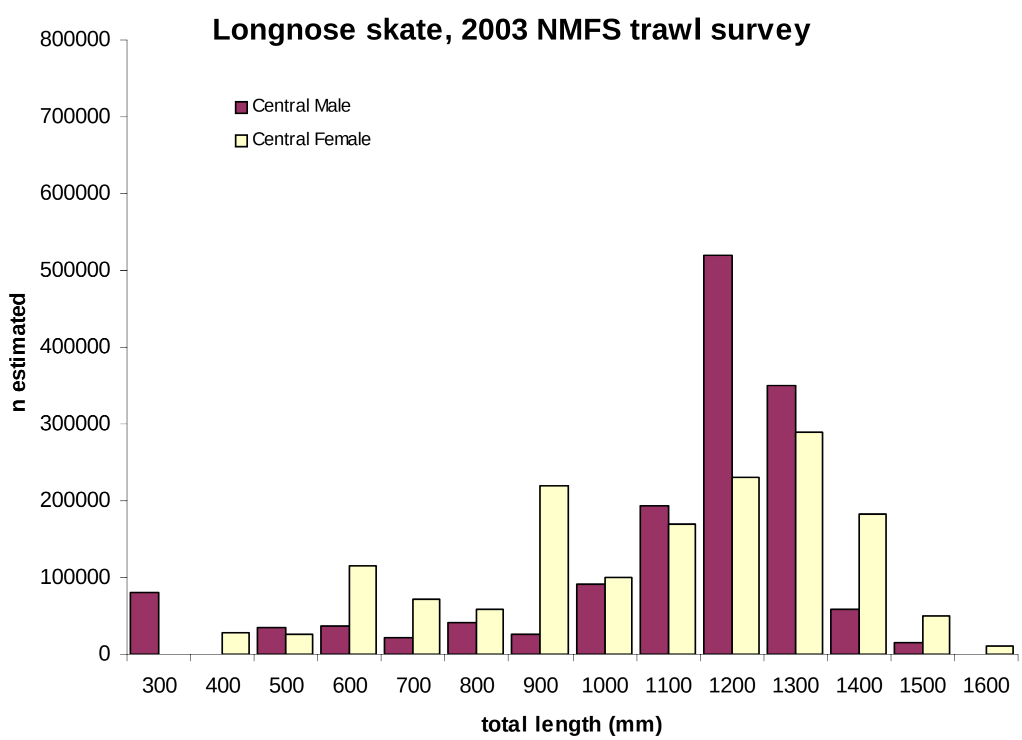
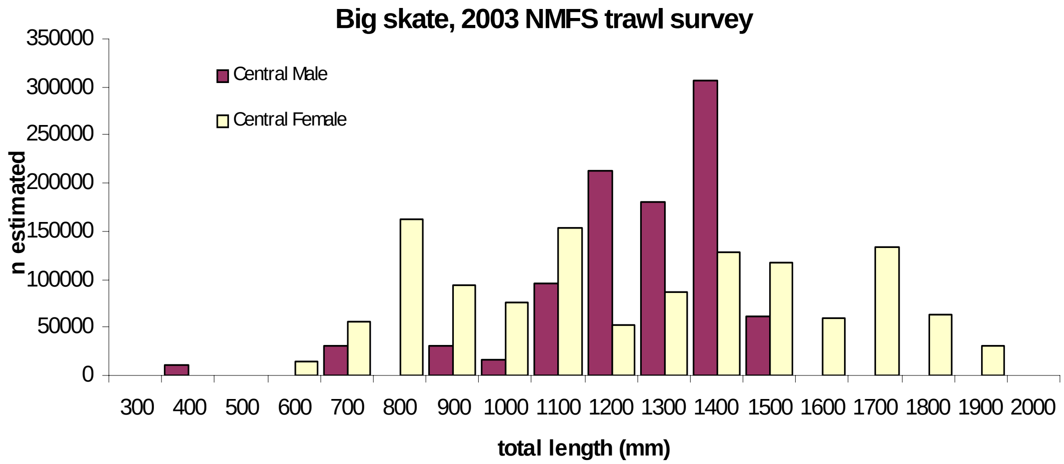
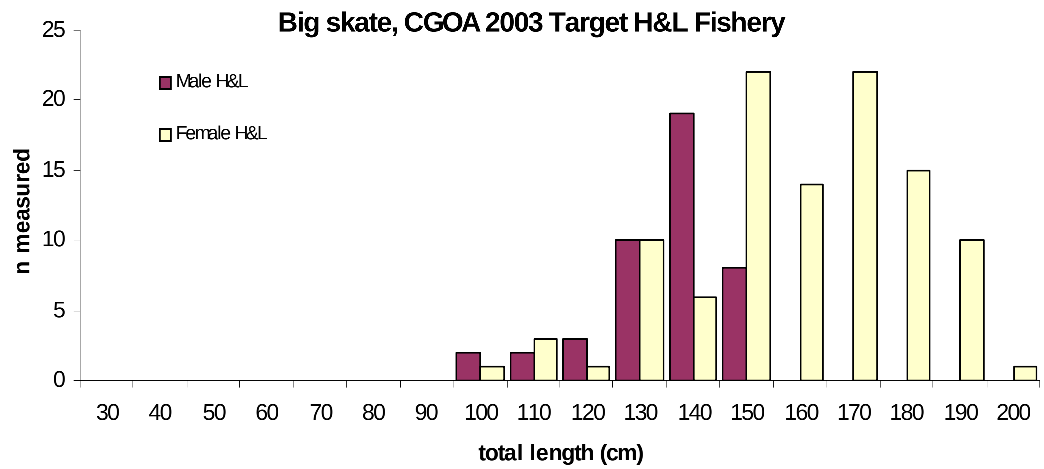




Figure 14. 2003 NMFS trawl survey size composition for big skates (top) and longnose skates (bottom) in the central GOA



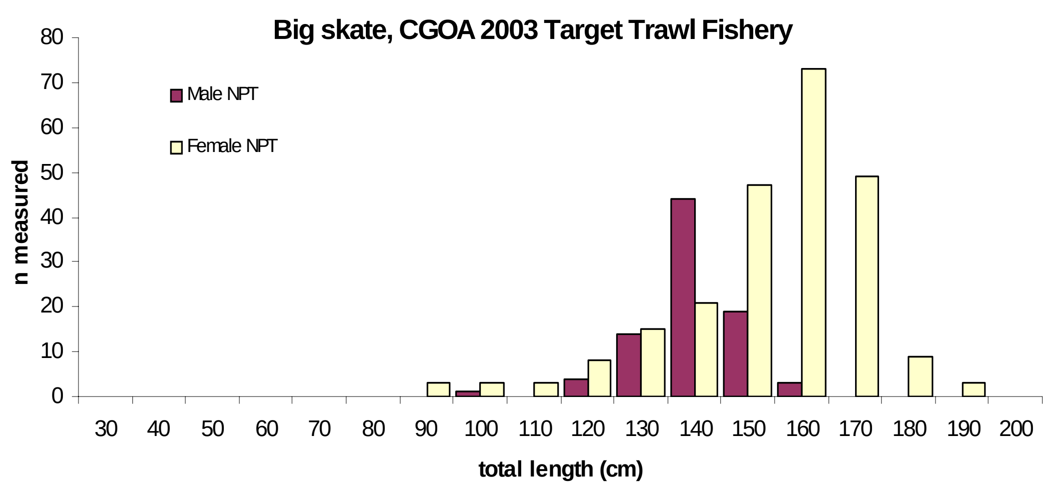




Figure 15. Comparison of estimated fishery catch at length for big skates with GOA trawl survey length composition for Central GOA big skates, 2003